(EEAP) LIGHTING SURVEY STUDY

AT THE

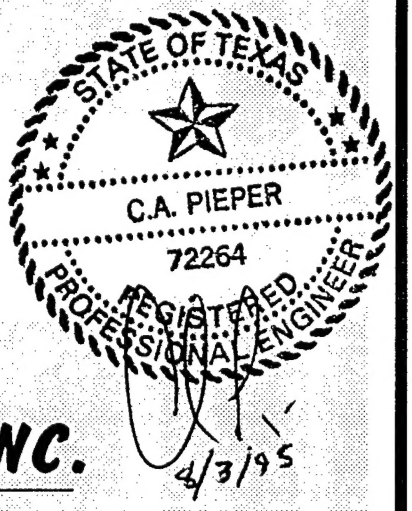
FORT BLISS

EL PASO, TEXAS

VOLUME I

FINAL REPORT

US Army Corps
of Engineers
Fort Worth Division



CONDUCTED BY

HUITT-ZOLLARS, INC.

CONSULTING ENGINEERS
FORT WORTH, TEXAS

8/3/95

(EEAP) Lighting Survey Study
at
Fort Bliss
El Paso, Texas

FINAL REPORT
August 3, 1995

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I. EXECUTIVE SUMMARY

A. Introduction

This energy conservation study was performed by Huitt-Zollars Inc, for the U.S. Army Engineer District (USAED), Fort Worth, under contract number DACAC63-94-D-0015. The study was conducted at Fort Bliss in El Paso, Texas, between October 31, 1994 and May 12, 1995. The site survey and data collection was performed by C.A. Pieper, P.E., Tom Luckett, Lighting Designer, and Merrel Nichols, CADD Technician.

The purpose of the study was to perform a limited site survey of specific buildings at the facility, identify specific Energy Conservation Opportunities (ECOs) that exist, and then evaluate these ECOs for technical and economic feasibility. These ECOs were limited to building interior lighting and it's effects on the heating, ventilating and air conditioning (HVAC) systems.

This survey was conducted with the assistance of many persons at the facility. Special thanks are extended to all of them, including the following individuals:

Mr. Joe Mathis, Energy Coordinator
Mr. Raymond Balderos, Utilities Sales Clerk
Mr. Louis Arenas, Electrical Maintenance Supervisor

Any questions concerning this report should be directed to the Project Manager, C.A. Pieper, P.E., at Huitt-Zollars Inc., 512 Main Street, Suite 1500, Fort Worth, Texas 76102. Phone 817-335-3000.

B. Buildings Studied

This study was conducted on a total of 132 buildings at Fort Bliss. Of this total number of buildings, there were 52 unique building types. All of the other buildings were duplicates of one of these unique buildings. A complete description of all buildings studied is provided on page 9. The total building area covered in this study was 1,818,828 sqft.

C. Present Energy Consumption

Base Year Energy Consumption: The total metered electrical and gas consumptions for 12 consecutive months, prior to this study, were obtained from the facility and are referred to as the 'base year'. These data are shown on page 12 and are summarized as follows:

Electrical	157.0 MWH
Gas	936,041 MCF

Lighting Energy Consumption: The present annual lighting energy consumption (HVAC not included) for the building areas studied was calculated on page B-3 as follows:

Lighting Energy	4,990,613 KWH
	3.1% of base year total

D. Energy Conservation Opportunity (ECO) Analysis

ECOs Rejected: After reviewing the data collected at the facility and considering all of the practical limitations involved, certain potential ECOs were rejected prior to performing calculations. These ECOs are summarized below with their reasons for rejection.

1. *Remove Lamps or Fixtures:* This ECO was rejected because all areas which were found that had excessive amounts of lighting were included in other ECOs which recommended replacement of the existing lighting with more efficient fixtures. The light levels for all overlighted areas were reduced in these calculations. See Appendix C.

2. *Install Additional Switches in Large Areas, Turn Lights Off:* Most of the building areas were found to be evenly occupied during working hours, and the addition of extra switches for groups of lights in a large area would not allow lights to be turned off. Those areas that had irregular or intermittent occupancy were considered for adding occupancy sensors to turn off lights. See item 7 below.

3. *Install Fluorescent Reflectors in Existing Fixtures:* This ECO requires installing the polished silver reflectors into 4 lamp fluorescent fixtures and then removing 2 lamps and a ballast. While this cuts the fixtures energy consumption in half, it also drops the lumen output from the fixture by at least 1/3, based on IES tests. Therefore, an area must be overlighted by at least 33% in order to maintain acceptable light levels. Very few areas were found that could meet this criteria.

4. *Replace Exit Signs With Low Wattage Signs:* There are many different types of exist signs at Fort Bliss, and many are not illuminated. Because there appears to be no stringent requirement for illuminated exit signs at the facility, any uniform replacement of the existing signs with low wattage illuminated signs would likely increase the lighting energy consumption. However, all new exit sign installations should be standardized to use only low wattage LED or fluorescent types, rather than the incandescent type.

5. *Install Compact Fluorescent Lamps in Incandescent Fixtures:* These new compact fluorescent lamps, which screw into existing lamp sockets, can easily be replaced with inefficient incandescent lamps. Also, they are limited in their application due to their large physical size. Finally, incandescent fixtures are designed for incandescent lamps, which have a very different light emission pattern than compact fluorescent lamps. Without the proper reflective surfaces in the fixtures, much of the new fluorescent light is trapped inside the fixture. This results in lower than expected lighting output from the existing fixtures. These lower light levels are often determined to be unacceptable by the occupants and the new fluorescent lamps are soon replaced with incandescent lamps. Since experience with this type of energy conservation retrofit has shown that the benefits cannot be guaranteed, this potential ECO has been rejected.

6. *Install Occupancy Sensors To Turn Off Lights:* Certain areas of the buildings were considered for installing occupancy sensors to turn off lights during unoccupied periods. However, these areas all had inefficient lighting which should be upgraded (see ECO-1 and 2). After upgrading the lighting in these areas, the potential amount of energy saved by installation of sensors is substantially reduced. Because of the reduction in potential energy and cost savings, this ECO was rejected. However, should the lighting not be upgraded as recommended, these sensors should be considered. Application data for occupancy sensors has been included in Appendix F.

ECOs Recommended: Certain ECOs which were identified during the building survey have been evaluated for technical and economic feasibility and are recommended for implementation. Complete documentation of all calculations as well as information required for implementation is included in Appendix C. These recommended ECOs are summarized below in order of descending Savings to Investment Ratio (SIR).

ECO 1: Replace Existing Incandescent And Mercury Vapor Lighting.

Electrical Energy Savings	913,758	KWH/yr
Electrical Demand Savings	6,412	KW-mo/yr
Natural Gas Energy Penalty	537.5	MMBTU/yr
Net Energy Savings	2,581	MMBTU/yr
Annual Cost Savings	274,583	$/yr
Total Investment	640,824	$
Simple Payback	2.3	yrs
SIR	6.38	

ECO 2: Replace Existing Fluorescent Lighting With Electronic Fluorescent Lighting

Electrical Energy Savings	1,614,040	KWH/yr
Electrical Demand Savings	9,191	KW-mo/yr
Natural Gas Energy Penalty	949.3	MMBTU/yr
Net Energy Savings	4,559	MMBTU/yr
Annual Cost Savings	231,039	$/yr
Total Investment	1,536,567	$
Simple Payback	6.6	yrs
SIR	2.24	

ECOs Not Recommended: All ECOs which were considered applicable at this facility, and were not rejected for reasons mentioned above, were recommended for implementation. Therefore, there are no ECOs which were calculated and were not recommended.

ECIP Projects Developed. The facility decided not to submit any projects for ECIP funding. All projects will be submitted for funding as Non-ECIP projects.

Non-ECIP Projects Developed. The energy coordinator decided to combine the two recommended ECOs together for implementation and create six projects by dividing the buildings studied into six groups. The following projects which resulted from this procedure will be submitted for funding as Non-ECIP projects. They are summarized below in order of descending Savings to Investment Ratio (SIR).

Project 5. Lighting Systems Upgrade

Buildings: 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357

Electrical Energy Savings	256,665	KWH/yr
Gas Energy Penalty	151	MCF/yr
Total Energy Savings	725	MMBTU/yr
Total Cost Savings	79,987	$/yr
Total Investment	228,724	$
Simple Payback	2.8	yrs
SIR	5.20	

Project 6. Lighting Systems Upgrade

Buildings: 2527, 2528, 2529, 2536, 2537, 2538, 2588, 5000, 5804, 5805, 5808, 5838, 5843, 5849, 5850, 5851, 5852, 5853, 5854, 5855, 5856, 5857, 5858, 5859, 5860, 5863, 5864

Electrical Energy Savings	748,315	KWH/yr
Gas Energy Penalty	440	MCF/yr
Total Energy Savings	2,114	MMBTU/yr
Total Cost Savings	126,135	$/yr
Total Investment	501,141	$
Simple Payback	3.9	yrs
SIR	3.74	

Project 4. Lighting Systems Upgrade

Buildings: 1101, 1102, 1103, 1104, 1105, 1106, 1111, 1112, 1113, 1114, 1115, 1116, 1117, 1118, 1119, 1120, 1122, 1123, 1124, 1178, 1179, 1180, 1181, 1270, 1271, 1272, 1273, 1274, 1275, 1276, 1277, 1278, 1279

Electrical Energy Savings	197,773	KWH/yr
Gas Energy Penalty	117	MCF/yr
Total Energy Savings	558	MMBTU/yr
Total Cost Savings	49,317	$/yr
Total Investment	221,949	$
Simple Payback	4.5	yrs
SIR	3.31	

Project 1. Lighting Systems Upgrade

Buildings: 1, 8, 11, 12, 13, 51, 54, 55, 56, 58, 111, 112, 113, 114, 115, 116, 117, 118, 311

Electrical Energy Savings	424,260	KWH/yr
Gas Energy Penalty	250	MCF/yr
Total Energy Savings	1,198	MMBTU/yr
Total Cost Savings	79,027	$/yr
Total Investment	372,139	$
Simple Payback	4.7	yrs
SIR	3.16	

Project 2. Lighting Systems Upgrade

Buildings: 500, 503, 504, 512, 515, 516

Electrical Energy Savings	529,739	KWH/yr
Gas Energy Penalty	312	MCF/yr
Total Energy Savings	1,496	MMBTU/yr
Total Cost Savings	86,872	$/yr
Total Investment	465,988	$
Simple Payback	5.3	yrs
SIR	2.77	

Project 3. Lighting Systems Upgrade

Buildings: 720, 721, 722, 723, 724, 725, 738, 739, 740, 745, 746, 747, 754, 755, 756, 762, 769

Electrical Energy Savings	370,934	KWH/yr
Gas Energy Penalty	218	MCF/yr
Total Energy Savings	1,048	MMBTU/yr
Total Cost Savings	61,184	$/yr
Total Investment	387,474	$
Simple Payback	6.3	yrs
SIR	2.35	

Recommended Maintenance & Operations Practices: The following maintenance and operations (M&O) practices are recommended to help conserve lighting energy at Fort Bliss.

1. The Energy Coordinator should work together with the Fort Bliss Director of Public Works to develop a Standard Specification for all future lighting repair and renovation projects. All facility lighting designers, as well as 'You Do It' designers, should be required to follow this specification. The energy coordinator should review all new lighting designs to check for compliance with the specifications. This will help to eliminate the inadvertent use of inefficient lighting systems at the facility.

2. Facility lighting designers should obtain and use published design lighting levels for all lighting renovation projects or new installations. This will help to eliminate overlighting.

3. The installation of new incandescent lighting should be prohibited. More efficient sources should be used in all cases.

4. The energy coordinator should attend training seminars for building energy managers, such as those listed in Appendix F.

5. The energy coordinator should direct considerable energy conservation efforts towards the production processes using electrical energy, as this is the largest area of potential savings. See page 12, *Utility Data*, for more details.

E. Energy And Cost Savings

Total Potential Energy and Cost Savings. The calculated energy and cost savings from the implementation of all the Non-ECIP projects is as follows:

Electrical Energy Savings	2,527,686	KWH/yr
Gas Energy Penalty	1,488	MCF/yr
Total Energy Savings	7,139	MMBTU/yr
Total Cost Savings	482,522	$/yr
Total Investment	2,177,415	$
Simple Payback	4.5	yrs

Energy Use and Costs Before and After. Based on the 'base year' electrical and gas energy consumptions and costs shown on page 12, and the calculated total potential savings above, the Fort Bliss energy and usage and costs before and after implementation of the Non-ECIP projects is as follows:

	Before	After
Electrical	157.0 MWH	154.4 MWH
Gas	936,041 MCF	937,529 MCF
Total Cost	11,663,837 $	11,181,315 $

Percentage Saved. Based on the base year electrical and gas energy consumptions and costs, the percentage of savings from all the Non-ECIP projects is as follows:

$$\textit{Electrical Energy Saved} = \left[\frac{2.5\ MWH}{157.0\ MWH}\right] = 1.6\%$$

$$\textit{Gas Energy Penalty} = \left[\frac{1{,}488\ MCF}{936{,}041\ MCF}\right] = 0.1\%$$

$$\textit{Energy Cost Savings} = \left[\frac{482{,}522\ \$}{11{,}663{,}837\ \$}\right] = 4.1\%$$

II. NARRATIVE REPORT

A. Entry Interview

Work Plan: An entry interview meeting was conducted at the Fort Bliss facility on October 31, 1994. Present at the meeting were two representatives of Huitt Zollars Inc., C.A. Pieper, *Project Manager*, and Tom Luckett, *Lighting Designer*. Also present was Mr. Joe Mathis, *Energy Coordinator*, Fort Bliss. At that time, a description of the work plan for this study was presented to Mr. Mathis by the Huitt Zollars staff. The work plan was a summary of the individual tasks to be performed to complete the lighting survey, and the approximate date that each task was to begin. Each step of the work plan was described in detail to Mr. Mathis. The work plan is shown in Figure 1.

Figure 1. Work Plan

10/31/94	Entry Interview Meeting
10/31/94	Lighting & Building Data Collection
12/19/94	Perform ECO Calculations
1/12/95	Interim Findings Submittal
5/12/95	Pre-Final Report Submittal
6/30/95	Final Report Submittal

Data List: After discussing the work plan, the energy coordinator was presented the list of data items shown in Figure 2, to be collected by the study team. This list was a summary of the information required by the surveyors. The study team and energy coordinator discussed the methods by which all of the data on the list were to be obtained. The data concerning the existing lighting systems and room light levels were to be collected from the walk through of the buildings, and recorded onto preprinted data forms, included in Appendix G. All other data were to be obtained from the facility personnel responsible for each item. The energy coordinator provided useful information on past energy conservation efforts, as well as any ongoing or future planned energy conservation measures. Also, he provided direction as to where to obtain other information on the data list. Any security passes that the surveyors needed to gain access to the facility were discussed and plans were made to obtain them.

Figure 2. Data Acquisition List

1. Existing lighting systems in buildings.
2. Existing light levels in buildings.
3. Building HVAC system efficiencies and operational hours.
4. Building size, age and remaining useful life.
5. Existing lighting operational periods and area usage.
6. Facility electricity, gas, other utility rates.
7. Facility electricity, gas, other utility consumptions.
8. Utility company rebate programs.
9. Past lighting energy conservation projects.
10. Proposed or planned lighting energy conservation projects.
11. Typical lighting maintenance procedures, costs and materials.
12. Typical lighting retrofit procedures.

ECO List: Following the discussion on the data list, Mr. Mathis was presented a list of specific Energy Conservation Opportunities (ECOs) that the surveyors were looking for. It included three general ways to conserve on lighting energy. The first method reduces lighting energy consumption by simply removing lamps or fixtures from areas which are currently overlighted or which could be modified to reduce the need for the existing quantity of lights. Light levels were to be measured by the surveyors and compared with design standards to determine whether or not an area was overlighted. The second method saves energy by turning lights off with additional switches, motion sensors or daylight sensors. Areas which were partially or intermittently unoccupied, or which had sufficient daylight from windows or skylights were to be located by the surveyors. The third method saves energy by reducing the wattage of the existing light source. The surveyors were to look for inefficient light sources within the buildings. These three general energy conservation strategies were discussed in detail with the energy coordinator, who provided feedback on potential applications at the facility. The ECO list is shown in Figure 3.

Figure 3. Energy Conservation Opportunity (ECO) List

1. Reduce / Enhance Lighting: Remove Lamps and or Fixtures.
   a) Overlighted areas
   b) Increase daylighting
   c) Lower fixtures
   d) Paint walls and ceiling light color.
2. Improve Lighting Controls: Turn Lights Off.
   a) Occupancy sensors
   b) Additional switches in large areas
3. Improve Lighting Efficiency: Reduce Lighting Wattage
   a) Replace incandescent source with more efficient source
   b) Install more efficient fluorescent lamps / ballasts / reflectors
   c) Replace existing HID with more efficient HID source

B. Data Collection

Building Data: This study at Fort Bliss in El Paso, Texas, was originally targeted at 150 buildings with a combined total of 2,121,223 sqft. See Appendix E, pages E-16 through E-23. However, during the data acquisition phase, some of these buildings were found to be on the base disposal list, and are due to be demolished. A total of 15 buildings, with a combined area of 302,395 sqft., were on this list. These buildings were therefore omitted from the study and are shown in Figure 4.

Figure 4. Buildings on Base Disposal List

BLDG. NO.	DESCRIPTION	AREA SQFT.
50	Administration	9,291
1109	Warehouse	15,960
1110	Warehouse	15,960
1121	Warehouse	15,960
1250	Maintenance Shop	29,093
2031	Laundry	52,913
2330	Instruction	6,966
2511	Motor Repair Shop	18,281
2512	Motor Repair Shop	18,281
2513	Motor Repair Shop	18,281
2514	Motor Repair Shop	22,635
2515	Motor Repair Shop	22,635
2516	Motor Repair Shop	18,281
2518	Motor Repair Shop	20,077
2519	Motor Repair Shop	18,281
Total Building Area		302,895

The buildings which were included in the study included warehouses, classroom facilities, maintenance facilities, administrative offices, and others such as a museum and a theater. Of these buildings, there were 58 unique building floor plans, and all of the others were duplicates. However, the Corps of Engineers limited the lighting study to no more than 52 unique building floor plans, and their associated duplicates to be studied. Therefore, complete lighting data was collected on only 52 unique buildings, and data sheets were filled out for them. The

others, which were considered duplicates, were compared to these unique buildings to verify their similarity. Lighting data collected for the unique buildings will be used for the duplicates also. However, slight variations in lighting systems and building usage may exist. These 52 unique buildings and their associated duplicates are listed in Figure 5.

All of the buildings were constructed between 1893 and 1963. Two of the oldest buildings are classified as historical buildings, but are still used by the post for administrative functions. These buildings have been renovated and are well maintained. Many of the warehouse and storage buildings are old and in fair to poor condition, while the office and classroom buildings are generally in better condition or newer. ECOs were calculated on all buildings where they were applicable, but the energy coordinator should verify the usefulness of each individual building prior to implementation of the ECOs. In some cases, the value of the new lighting system may exceed the value of the building.

Figure 5. Unique And Similar Buildings Included In Study

UNIQUE BLDG. NO.	SIMILAR BUILDINGS INCLUDED IN STUDY
1	
8	
11	112, 114, 115, 116, 117
12	113, 118
13	
51	
54	
55	
56	
58	
111	
311	
500	503, 504
512	515, 516
720	721
722	
723	745
724	
725	
738	739, 740, 756
746	747
754	755
762	
769	
1101	1113, 1114, 1115, 1116, 1119, 1120, 1122, 1123, 1124
1102	1103, 1104, 1117, 1118
1105	1111
1106	1112
1178	1179, 1180, 1181
1270	1276, 1277, 1278, 1279
1271	1272, 1273, 1274, 1275
2322	2323, 2324, 2325
2320	2321, 2326, 2327, 2331, 2332, 2336, 2337, 2340, 2341, 2342 2343, 2347, 2350, 2351, 2353, 2355
2333	2334, 2335, 2344, 2345, 2346, 2352, 2357
2354	2356
2527	
2528	
2529	
2536	2537, 2338
2588	
5000	
5804	
5805	
5808	
5838	5843, 5851, 5856
5849	5850, 5853
5852	
5854	
5855	5857, 5860
5858	
5859	
5863	5864

Mechanical cooling at Fort Bliss is provided mainly by evaporative coolers, but some buildings have DX split systems or small chilled water systems. Heating is mainly provided by gas boilers or gas fired furnaces in the buildings. The post purchases the electrical power from the El Paso Electric Company and natural gas from the Southern Union Gas Company. An analysis of the rates charged by each of these utility companies is included in Appendix A.

Lighting Data: In order to collect the existing lighting data, a walk through of the buildings was performed. During the walk through, the auditors went room by room, recording the quantity and type of existing lighting systems, measured average light levels, and potential ECOs available. These data were recorded onto the data forms included in Appendix G. Building maps are also included in Appendix G, which show room numbers corresponding to those listed on the data forms. This will allow the facility staff, as well as the study team, to readily identify the existing lighting conditions anywhere in the buildings studied. Many areas have very old incandescent, mercury vapor or fluorescent lighting which should be replaced whenever possible.

Maintenance Data: Lighting maintenance at Fort Bliss is difficult due to the size of the facility, the number of light fixtures, and the reduced size of the maintenance staff. Many lights remain burned out for several weeks in some areas, and relamping takes place on a spot basis. The electrical maintenance department is beginning to use fluorescent T-8 lamps and electronic ballasts in new installations, but still stocks standard fluorescent lamps and ballasts, as well as inefficient mercury vapor and incandescent lamps.

The facility energy coordinator is not involved in all of the lighting maintenance and renovation projects, but whenever he is involved, he has directed that all lighting projects use the latest, most efficient light source available. The energy coordinator will use this lighting study to initiate interior lighting energy conservation projects at the post. Many lighting renovation projects are completed by individual military units in the buildings that they occupy. These so called 'You Do It' projects are completed without review by the energy coordinator and therefore are not held to any design guidelines which may exist in order to conserve energy.

During the building walk through, the following additional observations were made.

1. Light fixtures remained in use over top of areas where partitions and ceilings had been added to create office space in large open buildings. These fixtures should have been removed.

2. Many rooms or areas were found unoccupied with all of the lights burning. Occupancy sensors should be installed wherever possible to turn these lights off.

3. Maintenance personnel had installed incandescent fixtures in buildings for task lighting. Fluorescent fixtures should have been used.

4. Many newly renovated areas were overlighted or had inefficient incandescent or mercury vapor lighting installed. Lighting design standards should be obtained and followed in future lighting projects, including 'You Do It' projects.

5. No efficient relamping standard is followed by the maintenance personnel. Energy efficient lamps, ballasts, fixtures, etc, should be required to be installed wherever possible.

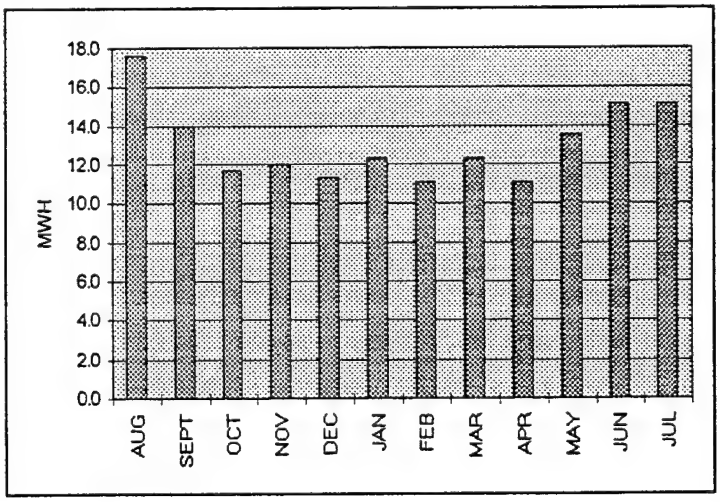
Utility Data: A 12 month utility billing history was obtained from the energy coordinator which covered the period of August 1993 through July 1994. This history included all of the metered electric and natural gas consumption for the post and is shown in Figure 6. The total cost of electricity for the base year was $9.04 million and the total cost for gas was $2.6 million. Note from Figure 6 that the monthly electrical demand (KW) is always well above the contract billing minimum of 10,000 KW per month, thereby allowing room for demand cost savings year round.

Figure 6. Base Year Utility Data

Billing Period	Electrical			Natural Gas	
	Demand KW	Consumption MWH	Cost $	Consumption MCF	Cost $
AUG	29,637	17.6	894,884	26,453	63,778
SEPT	28,337	14.0	815,995	17,015	40,274
OCT	24,641	11.7	712,204	42,085	124,360
NOV	21,563	12.0	716,600	148,969	433,499
DEC	21,949	11.3	700,604	171,134	500,054
JAN	22,828	12.3	723,462	176,985	498,743
FEB	23,182	11.1	698,283	153,509	438,115
MAR	22,697	12.3	723,331	55,967	156,987
APR	23,278	11.1	698,730	58,266	163,437
MAY	25,824	13.5	752,534	30,803	78,855
JUN	29,568	15.1	789,639	32,400	72,996
JUL	29,298	15.1	814,514	22,455	51,959
Total	302,802	157.0	9,040,780	936,041	2,623,057

Charts of the base year electrical and gas energy usages were plotted and are shown in Figures 7 and 8. Looking at Figure 7, it can be assumed that the facility cooling energy is basically all KWH over about 12.0 MWH per month. The calculated 0.415 MWH per month of lighting energy (see Appendix B), is but a small percentage of this monthly electrical baseline. It would seem then that 'process' energy consumption contributes greatly to the monthly total, and is possibly the largest area of usage. Process electrical energy use should be targeted specifically for possible energy conservation retrofit projects.

Figure 7. Fort Bliss Electrical Usage 1993-94

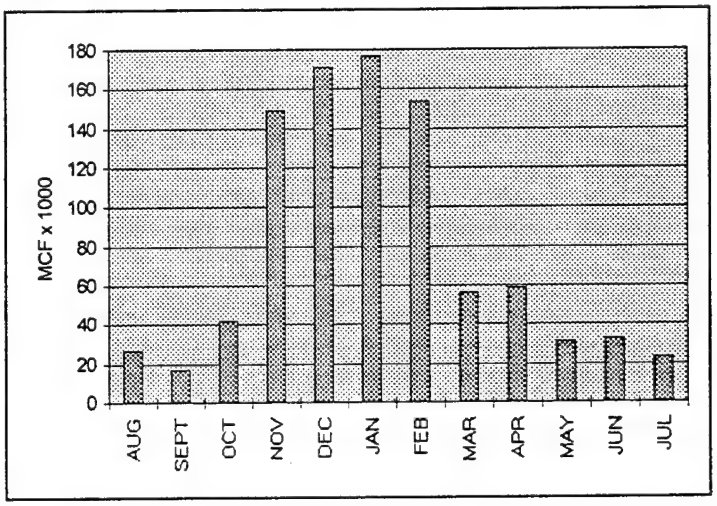


Looking at Figure 8, the monthly baseline of gas usage is about 220 MCF, which is domestic and process hot water, as well as food service energy. It is clear that heating is the main use of gas

at the facility, based on the obvious peak between October and May. Still, some energy savings might be obtained by directing some conservation efforts at the baseline usage of gas at the facility.

The electric utility rate schedule from the El Paso Electric Company, and the natural gas rate schedule from Southern Union Gas Company are included in Appendix A. There is currently a rebate available from the electric company for certain lighting energy conservation projects (see Appendix B). The current avoided costs for electricity and gas are $0.0220 per KWH, $21.50 per KW of peak demand, and $2.268 per MCF of gas. These avoided costs are the marginal savings per unit of energy and demand savings at the facility. See Appendix A for a complete analysis of the utility rates.

Figure 8. Fort Bliss Natural Gas Usage 1993-94



C. Plan To Implement Projects:

Project Funding: The forms DD-1391, the associated cost estimates and life cycle cost analysis summary sheets for all lighting upgrade projects are provided on pages 16 to 39. These are to be submitted for project funding, along with the calculations in Appendix C if required.

Programming Phase: These lighting upgrade projects will require some design effort in order to produce contract drawings and specifications for the replacement of incandescent and mercury vapor lighting and the installation of electronic ballasts and T8 lamps in existing fluorescent fixtures. Therefore, an engineering firm should be retained for this purpose. Using the data forms in Appendix G and as-built drawings of the existing building lighting systems, the design firm can produce construction drawings of the new lighting systems. They should pay close attention to the type of new fixtures and equipment specified. For the replacement of incandescent and mercury vapor lighting, the recommended new light sources are shown in Figure 9, along with the Appendix page numbers where sample light fixture data has been provided. These sample light fixtures are presented as a guide only and may not be suitable in every case. The lighting designer should make the final decision on a room by room basis.

Figure 9. Suggested Replacement Light Fixtures

EXIST FIXTURE LIGHT SOURCE	EXIST INPUT WATTS	SUGGESTED NEW FIXTURE LIGHT SOURCE	SAMPLE NEW LIGHT FIXTURE SHOWN, PAGE
40W INC	40	18W FLUOR	F-20
60W INC	60	18W FLUOR	F-20
100W INC	100	26W FLUOR	F-20
150W INC	150	32W FLUOR	F-22
200W INC	200	(2) 32W FLUOR	F-23
300W INC	300	(3) 32W FLUOR	F-24
500W INC.	500	(4) 32W FLUOR	F-27
250W MERC	300	150W HPS	F-25
400W MERC	480	200W HPS	F-26
1000W QUARTZ	1,000	400W HPS	F-27

For the fluorescent lighting systems, the designer should simply specify T8 lamps and electronic ballasts with sockets where required. In some cases, it may be less expensive to simply replace the existing fixtures with new ones. This also should be determined by the designer on a room by room basis. Once the construction drawings and specifications have been produced by the design firm, they should be reviewed and approved by the energy coordinator to check for compliance with the intent of the ECOs included in this study.

Bidding Phase: Once final approval of the construction drawings and specifications has been given, they can be used to obtain construction bids from local contractors. This should be handled in the manner normally followed by the post for construction projects.

Construction Phase: Once a contractor has been selected for the projects, the energy coordinator should review all submittals and shop drawings provided by the contractor to check the proposed

lighting fixtures and equipment for compliance with the intent of the ECOs. This will ensure that the proper fixtures and equipment are installed in the buildings and that the estimated energy and cost savings will be realized.

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Fort Bliss, Texas	Lighting Systems Upgrade - Project 1

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			372.1

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Conversion of existing fluorescent light fixtures to use T8 lamps and electronic ballasts, and replacement of existing incandescent and mercury vapor lighting with fluorescent and high pressure sodium lighting. See attached cost estimate for itemized breakdown of project. This work shall be performed in buildings no. 1, 8, 11, 12, 13, 51, 54, 55, 56, 58, 111, 112, 113, 114, 115, 116, 117, 118 and 311.	EA	1	372.1	372.1
ESTIMATED CONTRACT COST				332.772
CONTINGENCY (0%)				0
SIOH				19.401
DESIGN				19.996
TOTAL REQUEST				372.139
TOTAL REQUEST (ROUNDED)				373.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A. Retrofit 1,927 existing fluorescent light fixtures with electronic ballasts and T8 lamps. This will require a total of 3,093 electronic ballasts for F32T8 lamps, 245 electronic ballasts for F96T8 lamps, 6,104 F32T8 lamps and 431 F96T8 lamps. The ballasts and lamps can be purchased from the DLA. The fixtures and lenses should be cleaned while the ballasts and lamps are replaced. In some cases, it may be less expensive to replace the existing fixtures with new fixtures that already have electronic ballasts and T8 lamps. This should be determined at the time that construction bids are recieved.

B. Remove 560 existing incandescent and mercury vapor light fixtures, and replace them with 465 new fluorescent and high pressure sodium light fixtures. The fixture types and quantities required are listed on the cost estimate attached. The fluorescent fixtures should be specified with electronic ballasts and T8 lamps. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same wherever possible.

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	
	Fort Bliss, Texas

4. PROJECT TITLE	5. PROJECT NUMBER
Lighting Systems Upgrade - Project 1	

11. REQUIREMENT

The project is required to reduce lighting energy consumption at Fort Bliss facilities. The project provides more efficient interior lighting systems, in order to save lighting energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these new lighting systems will result in the following:

Electrical Savings	424,260	KWH/yr
Gas Penalty	250	MCF/yr
Total Energy Savings	1,198	MMBTU/yr
Cost Savings	79,027	$/yr
Payback Period	4.7	yrs
SIR	3.16	

CURRENT SITUATION:

A. The installation currently has much fluorescent lighting in it's buildings. These existing light fixtures typically have the T12 lamps and standard magnetic ballasts. The existing ballasts and lamps should be replaced with new electronic ballasts and T8 lamps, or completely new electronic fluorescent fixtures should be installed, if less expensive. These electronic fluorescent lamps and ballasts are more efficient and use less energy.

B. The facility also has numerous incandescent and mercury vapor lighting systems in it's buildings. These existing light sources are inefficient and should be replaced with more efficient light sources, such as fluorescent and high pressure sodium.

IMPACT IF NOT PROVIDED

If this project is not provided, a reduction of 1,198 MMBTU per year of energy and $79,027 of utility and maintenance costs will continue to be wasted. There will be no contribution to energy reduction goals established at the facility.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: BLISS
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT BLISS REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-03 EEAP LIGHTING STUDY SURVEY
FISCAL YEAR 1995 DISCRETE PORTION NAME: PROJECT1
ANALYSIS DATE: 03-17-95 ECONOMIC LIFE 20 YEARS PREPARED BY: PIEPER

1. INVESTMENT

A. CONSTRUCTION COST	$ 332772.		
B. SIOH	$ 19401.		
C. DESIGN COST	$ 19966.		
D. TOTAL COST (1A+1B+1C)	$ 372139.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0.		
F. PUBLIC UTILITY COMPANY REBATE	$ 0.		
G. TOTAL INVESTMENT (1D - 1E - 1F)		$	372139.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.46	1448.	$ 9354.	15.08	$ 141060.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.27	-250.	$ -567.	18.58	$ -10535.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 48762.	14.88	$ 725579.
N. TOTAL		1198.	$ 57549.		$ 856103.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 21478.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 319593.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)	$	319593.
4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))	$	79027.
5. SIMPLE PAYBACK PERIOD (1G/4)		4.71 YEARS
6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C)	$	1175696.
7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)=		3.16
(IF < 1 PROJECT DOES NOT QUALIFY)		
8. ADJUSTED INTERNAL RATE OF RETURN (AIRR):		9.10 %

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Fort Bliss, Texas, building Nos. 1, 8, 11, 12, 13, 51, 54, 55, 56, 58, 111, 112, 113, 114, 115, 116, 117, 118, 311

PROJECT NO: 03-0185.01 **DATE:** 3/17/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: Lighting Systems Upgrade - Project 1

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing incandescent light fixtures	560	ea	1.0	10.00	5,600			5,600
Demolition of existing mercury vapor light fixtures		ea	1.0	15.00				
Miscellaneous cutting and patching of ceilings	560	ea	1.0	5.00	2,800	5.00	2,800	5,600
Miscellaneous wire, conduit and electrical parts	465	ea	1.0	5.00	2,325	5.00	2,325	4,650
Installation of new 18W fluorescent light fixtures		ea	1.0	30.00		60.00		
Installation of new 25W fluorescent light fixtures	34	ea	1.0	30.00	1,020	70.00	2,380	3,400
Installation of new 32W fluorescent light fixtures		ea	1.0	30.00		80.00		
Installation of new 2 lamp, 32W fluorescent light fixtures	1	ea	1.0	30.00	30	80.00	80	110
Installation of new 3 lamp, 32W fluorescent light fixtures	24	ea	1.0	30.00	720	100.00	2,400	3,120
Installation of new 4 lamp, 32W fluorescent light fixtures	120	ea	1.0	30.00	3,600	100.00	12,000	15,600
Installation of new 150W, HPS lowbay fixtures	135	ea	1.0	45.00	6,075	200.00	27,000	33,075
Installation of new 200W, HPS lowbay fixtures	136	ea	1.0	45.00	6,120	250.00	34,000	40,120
Installation of new 400W, HPS lowbay fixtures	15	ea	1.0	45.00	675	300.00	4,500	5,175
Installation of new lamp sockets in existing fluorescent fixtures	3,338	ea	1.0	5.00	16,690	8.00	26,704	43,394
Installation of new F32T8 electronic ballasts	3,093	ea	1.0	15.00	46,395	16.70	51,653	98,048
Installation of new F32T8 lamps and sockets	6104	ea	1.0			2.65	16,176	16,176
Installation of new F59T8 electronic ballasts	245	ea	1.0	15.00	3,675	29.38	7,198	10,873
Installation of new F59T8 lamps and sockets	431	ea	1.0			10.27	4,426	4,426
				SUBTOTAL	95,725		193,642	289,367
				O & P @ 20%	19,145		38,728	43,405
				SUBTOTAL	114,870		232,370	332,772
				DESIGN @ 6%				19,966
				SUBTOTAL				352,738
				SIOH @ 5.5%				19,401
				TOTAL				$372,139

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Fort Bliss, Texas	Lighting Systems Upgrade - Project 2

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			465.9

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Conversion of existing fluorescent light fixtures to use T8 lamps and electronic ballasts, and replacement of existing incandescent and mercury vapor lighting with fluorescent and high pressure sodium lighting. See attached cost estimate for itemized breakdown of project. This work shall be performed in buildings no. 500, 503, 504, 512, 515, 516.	EA	1	465.9	465.9
ESTIMATED CONTRACT COST				416.693
CONTINGENCY (0%)				0
SIOH				24.293
DESIGN				25.002
TOTAL REQUEST				465.988
TOTAL REQUEST (ROUNDED)				466.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A. Retrofit 2,775 existing fluorescent light fixtures with electronic ballasts and T8 lamps. This will require a total of 5,538 electronic ballasts for F32T8 lamps, 6 electronic ballasts for F96T8 lamps, 11,076 F32T8 lamps and 12 F96T8 lamps. The ballasts and lamps can be purchased from the DLA. The fixtures and lenses should be cleaned while the ballasts and lamps are replaced. In some cases, it may be less expensive to replace the existing fixtures with new fixtures that already have electronic ballasts and T8 lamps. This should be determined at the time that construction bids are recieved.

B. Remove 387 existing incandescent and mercury vapor light fixtures, and replace them with 318 new fluorescent and high pressure sodium light fixtures. The fixture types and quantities required are listed on the cost estimate attached. The fluorescent fixtures should be specified with electronic ballasts and T8 lamps. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same wherever possible.

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	
	Fort Bliss, Texas

4. PROJECT TITLE	5. PROJECT NUMBER
Lighting Systems Upgrade - Project 2	

11. REQUIREMENT

The project is required to reduce lighting energy consumption at Fort Bliss facilities. The project provides more efficient interior lighting systems, in order to save lighting energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these new lighting systems will result in the following:

Electrical Savings	529,739	KWH/yr
Gas Penalty	312	MCF/yr
Total Energy Savings	1,496	MMBTU/yr
Cost Savings	86,872	$/yr
Payback Period	5.3	yrs
SIR	2.77	

CURRENT SITUATION:

A. The installation currently has much fluorescent lighting in it's buildings. These existing light fixtures typically have the T12 lamps and standard magnetic ballasts. The existing ballasts and lamps should be replaced with new electronic ballasts and T8 lamps, or completely new electronic fluorescent fixtures should be installed, if less expensive. These electronic fluorescent lamps and ballasts are more efficient and use less energy.

B. The facility also has numerous incandescent and mercury vapor lighting systems in it's buildings. These existing light sources are inefficient and should be replaced with more efficient light sources, such as fluorescent and high pressure sodium.

IMPACT IF NOT PROVIDED

If this project is not provided, a reduction of 1,496 MMBTU per year of energy and $86,872 of utility and maintenance costs will continue to be wasted. There will be no contribution to energy reduction goals established at the facility.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: BLISS
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT BLISS REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-03 EEAP LIGHTING STUDY SURVEY
FISCAL YEAR 1995 DISCRETE PORTION NAME: PROJECT2
ANALYSIS DATE: 03-17-95 ECONOMIC LIFE 20 YEARS PREPARED BY: PIEPER

1. INVESTMENT

A. CONSTRUCTION COST	$ 416693.	
B. SIOH	$ 24293.	
C. DESIGN COST	$ 25002.	
D. TOTAL COST (1A+1B+1C)	$ 465988.	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0.	
F. PUBLIC UTILITY COMPANY REBATE	$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)		$ 465988.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.46	1808.	$ 11680.	15.08	$ 176130.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.27	-312.	$ -708.	18.58	$ -13148.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 60974.	14.88	$ 907293.
N. TOTAL		1496.	$ 71946.		$ 1070275.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 14926.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 222099.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 222099.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 86872.

5. SIMPLE PAYBACK PERIOD (1G/4) 5.36 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1292374.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.77
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 8.39 %

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Fort Bliss, Texas, building Nos. 500, 503, 504, 512, 515, 516

PROJECT NO: 03-0185.01 **DATE:** 3/17/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: Lighting Systems Upgrade - Project 2

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing incandescent light fixtures	387	ea	1.0	10.00	3,870			3,870
Demolition of existing mercury vapor light fixtures		ea	1.0	15.00				
Miscellaneous cutting and patching of ceilings	387	ea	1.0	5.00	1,935	5.00	1,935	3,870
Miscellaneous wire, conduit and electrical parts	318	ea	1.0	5.00	1,590	5.00	1,590	3,180
Installation of new 18W fluorescent light fixtures		ea	1.0	30.00		60.00		
Installation of new 25W fluorescent light fixtures		ea	1.0	30.00		70.00		
Installation of new 32W fluorescent light fixtures		ea	1.0	30.00		80.00		
Installation of new 2 lamp, 32W fluorescent light fixtures		ea	1.0	30.00		80.00		
Installation of new 3 lamp, 32W fluorescent light fixtures	15	ea	1.0	30.00	450	100.00	1,500	1,950
Installation of new 4 lamp, 32W fluorescent light fixtures	72	ea	1.0	30.00	2,160	100.00	7,200	9,360
Installation of new 150W, HPS lowbay fixtures	117	ea	1.0	45.00	5,265	200.00	23,400	28,665
Installation of new 200W, HPS lowbay fixtures	105	ea	1.0	45.00	4,725	250.00	26,250	30,975
Installation of new 400W, HPS lowbay fixtures	9	ea	1.0	45.00	405	300.00	2,700	3,105
Installation of new lamp sockets in existing fluorescent fixtures	5,544	ea	1.0	5.00	27,720	8.00	44,352	72,072
Installation of new F32T8 electronic ballasts	5,538	ea	1.0	15.00	83,070	16.70	92,485	175,555
Installation of new F32T8 lamps and sockets	11076	ea	1.0			2.65	29,351	29,351
Installation of new F59T8 electronic ballasts	6	ea	1.0	15.00	90	29.38	176	266
Installation of new F59T8 lamps and sockets	12	ea	1.0			10.27	123	123
				SUBTOTAL	131,280		231,062	362,342
				O & P @ 20%	26,256		46,212	54,351
				SUBTOTAL	157,536		277,274	416,693
				DESIGN @ 6%				25,002
				SUBTOTAL				441,695
				SIOH @ 5.5%				24,293
				TOTAL				$465,988

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Fort Bliss, Texas	Lighting Systems Upgrade - Project 3

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			387.4

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Conversion of existing fluorescent light fixtures to use T8 lamps and electronic ballasts, and replacement of existing incandescent and mercury vapor lighting with fluorescent and high pressure sodium lighting. See attached cost estimate for itemized breakdown of project. This work shall be performed in buildings no. 720, 721, 722, 723, 724, 725, 738, 739, 740, 745, 746, 747, 754, 755, 756, 762, 769.	EA	1	387.4	387.4
ESTIMATED CONTRACT COST				346.485
CONTINGENCY (0%)				0
SIOH				20.200
DESIGN				20.789
TOTAL REQUEST				387.474
TOTAL REQUEST (ROUNDED)				388.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A. Retrofit 2,405 existing fluorescent light fixtures with electronic ballasts and T8 lamps. This will require a total of 4,422 electronic ballasts for F32T8 lamps, 388 electronic ballasts for F96T8 lamps, 8,624 F32T8 lamps and 524 F96T8 lamps. The ballasts and lamps can be purchased from the DLA. The fixtures and lenses should be cleaned while the ballasts and lamps are replaced. In some cases, it may be less expensive to replace the existing fixtures with new fixtures that already have electronic ballasts and T8 lamps. This should be determined at the time that construction bids are recieved.

B. Remove 278 existing incandescent and mercury vapor light fixtures, and replace them with 235 new fluorescent and high pressure sodium light fixtures. The fixture types and quantities required are listed on the cost estimate attached. The fluorescent fixtures should be specified with electronic ballasts and T8 lamps. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same wherever possible.

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION

Fort Bliss, Texas

4. PROJECT TITLE	5. PROJECT NUMBER
Lighting Systems Upgrade - Project 3	

11. REQUIREMENT

The project is required to reduce lighting energy consumption at Fort Bliss facilities. The project provides more efficient interior lighting systems, in order to save lighting energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these new lighting systems will result in the following:

Electrical Savings	370,934	KWH/yr
Gas Penalty	218	MCF/yr
Total Energy Savings	1,048	MMBTU/yr
Cost Savings	61,184	$/yr
Payback Period	6.3	yrs
SIR	2.35	

CURRENT SITUATION:

A. The installation currently has much fluorescent lighting in it's buildings. These existing light fixtures typically have the T12 lamps and standard magnetic ballasts. The existing ballasts and lamps should be replaced with new electronic ballasts and T8 lamps, or completely new electronic fluorescent fixtures should be installed, if less expensive. These electronic fluorescent lamps and ballasts are more efficient and use less energy.

B. The facility also has numerous incandescent and mercury vapor lighting systems in it's buildings. These existing light sources are inefficient and should be replaced with more efficient light sources, such as fluorescent and high pressure sodium.

IMPACT IF NOT PROVIDED

If this project is not provided, a reduction of 1,048 MMBTU per year of energy and $61,184 of utility and maintenance costs will continue to be wasted. There will be no contribution to energy reduction goals established at the facility.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: BLISS
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT BLISS REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-03 EEAP LIGHTING STUDY SURVEY
FISCAL YEAR 1995 DISCRETE PORTION NAME: PROJECT3
ANALYSIS DATE: 03-17-95 ECONOMIC LIFE 20 YEARS PREPARED BY: PIEPER

1. INVESTMENT

A. CONSTRUCTION COST	$ 346485.	
B. SIOH	$ 20200.	
C. DESIGN COST	$ 20789.	
D. TOTAL COST (1A+1B+1C)	$ 387474.	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0.	
F. PUBLIC UTILITY COMPANY REBATE	$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)		$ 387474.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.46	1266.	$ 8178.	15.08	$ 123330.
B. DLST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.27	-218.	$ -494.	18.58	$ -9186.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 42742.	14.88	$ 636001.
N. TOTAL		1048.	$ 50426.		$ 750144.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 10758.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 160079.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)	$ 160079.
4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))	$ 61184.
5. SIMPLE PAYBACK PERIOD (1G/4)	6.33 YEARS
6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C)	$ 910223.
7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= (IF < 1 PROJECT DOES NOT QUALIFY)	2.35
8. ADJUSTED INTERNAL RATE OF RETURN (AIRR):	7.49 %

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Fort Bliss, Texas, building Nos. 720, 721, 722, 723, 724, 725, 738, 739, 740, 745, 746, 747, 754, 755, 756, 762, 769

PROJECT NO: 03-0185.01 **DATE:** 3/17/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: Lighting Systems Upgrade - Project 3

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing incandescent light fixtures	278	ea	1.0	10.00	2,780			2,780
Demolition of existing mercury vapor light fixtures		ea	1.0	15.00				
Miscellaneous cutting and patching of ceilings	278	ea	1.0	5.00	1,390	5.00	1,390	2,780
Miscellaneous wire, conduit and electrical parts	235	ea	1.0	5.00	1,175	5.00	1,175	2,350
Installation of new 18W fluorescent light fixtures		ea	1.0	30.00		60.00		
Installation of new 25W fluorescent light fixtures	58	ea	1.0	30.00	1,740	70.00	4,060	5,800
Installation of new 32W fluorescent light fixtures		ea	1.0	30.00		80.00		
Installation of new 2 lamp, 32W fluorescent light fixtures	1	ea	1.0	30.00	30	80.00	80	110
Installation of new 3 lamp, 32W fluorescent light fixtures	10	ea	1.0	30.00	300	100.00	1,000	1,300
Installation of new 4 lamp, 32W fluorescent light fixtures	44	ea	1.0	30.00	1,320	100.00	4,400	5,720
Installation of new 150W, HPS lowbay fixtures	74	ea	1.0	45.00	3,330	200.00	14,800	18,130
Installation of new 200W, HPS lowbay fixtures	48	ea	1.0	45.00	2,160	250.00	12,000	14,160
Installation of new 400W, HPS lowbay fixtures		ea	1.0	45.00		300.00		
Installation of new lamp sockets in existing fluorescent fixtures	4,810	ea	1.0	5.00	24,050	8.00	38,480	62,530
Installation of new F32T8 electronic ballasts	4,422	ea	1.0	15.00	66,330	16.70	73,847	140,177
Installation of new F32T8 lamps and sockets	8624	ea	1.0			2.65	22,854	22,854
Installation of new F59T8 electronic ballasts	388	ea	1.0	15.00	5,820	29.38	11,399	17,219
Installation of new F59T8 lamps and sockets	524	ea	1.0			10.27	5,381	5,381
				SUBTOTAL	110,425		190,866	301,291
				O & P @ 20%	22,085		38,173	45,194
				SUBTOTAL	132,510		229,039	346,485
				DESIGN @ 6%				20,789
				SUBTOTAL				367,274
				SIOH @ 5.5%				20,200
				TOTAL				$387,474

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Fort Bliss, Texas	Lighting Systems Upgrade - Project 4

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			221.9

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Conversion of existing fluorescent light fixtures to use T8 lamps and electronic ballasts, and replacement of existing incandescent and mercury vapor lighting with fluorescent and high pressure sodium lighting. See attached cost estimate for itemized breakdown of project. This work shall be performed in buildings no. 1101, 1102, 1103, 1104, 1105, 1106, 1111, 1112, 1113, 1114, 1115, 1116, 1117, 1118, 1119, 1120, 1122, 1123, 1124, 1178, 1179, 1180, 1181, 1270, 1271, 1272, 1273, 1274, 1275, 1276, 1277, 1278, 1279.	EA	1	221.9	221.9
ESTIMATED CONTRACT COST				198.470
CONTINGENCY (0%)				0
SIOH				11.571
DESIGN				11.908
TOTAL REQUEST				221.949
TOTAL REQUEST (ROUNDED)				222.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A. Retrofit 1,075 existing fluorescent light fixtures with electronic ballasts and T8 lamps. This will require a total of 1,778 electronic ballasts for F32T8 lamps, 372 electronic ballasts for F96T8 lamps, 3,550 F32T8 lamps and 382 F96T8 lamps. The ballasts and lamps can be purchased from the DLA. The fixtures and lenses should be cleaned while the ballasts and lamps are replaced. In some cases, it may be less expensive to replace the existing fixtures with new fixtures that already have electronic ballasts and T8 lamps. This should be determined at the time that construction bids are recieved.

B. Remove 401 existing incandescent and mercury vapor light fixtures, and replace them with 305 new fluorescent and high pressure sodium light fixtures. The fixture types and quantities required are listed on the cost estimate attached. The fluorescent fixtures should be specified with electronic ballasts and T8 lamps. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same wherever possible.

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	
	Fort Bliss, Texas

4. PROJECT TITLE	5. PROJECT NUMBER
Lighting Systems Upgrade - Project 4	

11. REQUIREMENT

The project is required to reduce lighting energy consumption at Fort Bliss facilities. The project provides more efficient interior lighting systems, in order to save lighting energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these new lighting systems will result in the following:

Electrical Savings	197,773	KWH/yr
Gas Penalty	117	MCF/yr
Total Energy Savings	558	MMBTU/yr
∴ Cost Savings	49,317	$/yr
Payback Period	4.5	yrs
SIR	3.31	

CURRENT SITUATION:

A. The installation currently has much fluorescent lighting in it's buildings. These existing light fixtures typically have the T12 lamps and standard magnetic ballasts. The existing ballasts and lamps should be replaced with new electronic ballasts and T8 lamps, or completely new electronic fluorescent fixtures should be installed, if less expensive. These electronic fluorescent lamps and ballasts are more efficient and use less energy.

B. The facility also has numerous incandescent and mercury vapor lighting systems in it's buildings. These existing light sources are inefficient and should be replaced with more efficient light sources, such as fluorescent and high pressure sodium.

IMPACT IF NOT PROVIDED

If this project is not provided, a reduction of 558 MMBTU per year of energy and $49,317 of utility and maintenance costs will continue to be wasted. There will be no contribution to energy reduction goals established at the facility.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: BLISS
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT BLISS REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-03 EEAP LIGHTING STUDY SURVEY
FISCAL YEAR 1995 DISCRETE PORTION NAME: PROJECT4
ANALYSIS DATE: 03-17-95 ECONOMIC LIFE 20 YEARS PREPARED BY: PIEPER

1. INVESTMENT

A. CONSTRUCTION COST	$ 198470.		
B. SIOH	$ 11571.		
C. DESIGN COST	$ 11908.		
D. TOTAL COST (1A+1B+1C)	$ 221949.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$	0.	
F. PUBLIC UTILITY COMPANY REBATE	$	0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 221949.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.46	675.	$ 4361.	15.08	$ 65756.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.27	-117.	$ -265.	18.58	$ -4930.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 37690.	14.88	$ 560827.
N. TOTAL		558.	$ 41785.		$ 621653.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 7532.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 112076.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)	$ 112076.
4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))	$ 49317.
5. SIMPLE PAYBACK PERIOD (1G/4)	4.50 YEARS
6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C)	$ 733729.
7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= (IF < 1 PROJECT DOES NOT QUALIFY)	3.31
8. ADJUSTED INTERNAL RATE OF RETURN (AIRR):	9.35 %

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Fort Bliss, Texas, building Nos. 1101, 1102, 1103, 1104, 1105, 1106, 1111, 1112, 1113, 1114, 1115, 1116, 1117, 1118, 1119, 1120, 1122, 1123, 1124, 1178, 1179, 1180, 1181, 1270, 1271, 1272, 1273, 1274, 1275, 1276, 1277, 1278, 1279

PROJECT NO: 03-0185.01 **DATE:** 3/17/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: Lighting Systems Upgrade - Project 4

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing incandescent light fixtures	389	ea	1.0	10.00	3,890			3,890
Demolition of existing mercury vapor light fixtures	12	ea	1.0	15.00	180			180
Miscellaneous cutting and patching of ceilings	401	ea	1.0	5.00	2,005	5.00	2,005	4,010
Miscellaneous wire, conduit and electrical parts	305	ea	1.0	5.00	1,525	5.00	1,525	3,050
Installation of new 18W fluorescent light fixtures		ea	1.0	30.00		60.00		
Installation of new 25W fluorescent light fixtures	6	ea	1.0	30.00	180	70.00	420	600
Installation of new 32W fluorescent light fixtures	12	ea	1.0	30.00	360	80.00	960	1,320
Installation of new 2 lamp, 32W fluorescent light fixtures		ea	1.0	30.00		80.00		
Installation of new 3 lamp, 32W fluorescent light fixtures	214	ea	1.0	30.00	6,420	100.00	21,400	27,820
Installation of new 4 lamp, 32W fluorescent light fixtures	15	ea	1.0	30.00	450	100.00	1,500	1,950
Installation of new 150W, HPS lowbay fixtures	30	ea	1.0	45.00	1,350	200.00	6,000	7,350
Installation of new 200W, HPS lowbay fixtures	28	ea	1.0	45.00	1,260	250.00	7,000	8,260
Installation of new 400W, HPS lowbay fixtures		ea	1.0	45.00		300.00		
Installation of new lamp sockets in existing fluorescent fixtures	2,150	ea	1.0	5.00	10,750	8.00	17,200	27,950
Installation of new F32T8 electronic ballasts	1,778	ea	1.0	15.00	26,670	16.70	29,693	56,363
Installation of new F32T8 lamps and sockets	3550	ea	1.0			2.65	9,408	9,408
Installation of new F59T8 electronic ballasts	372	ea	1.0	15.00	5,580	29.38	10,929	16,509
Installation of new F59T8 lamps and sockets	382	ea	1.0			10.27	3,923	3,923
				SUBTOTAL	60,620		111,963	172,583
				O & P @ 20%	12,124		22,393	25,887
				SUBTOTAL	72,744		134,356	198,470
				DESIGN @ 6%				11,908
				SUBTOTAL				210,378
				SIOH @ 5.5%				11,571
				TOTAL				$221,949

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
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(817) 335-3000 * FAX (817) 335-1025

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Fort Bliss, Texas	Lighting Systems Upgrade - Project 5

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			228.7

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Conversion of existing fluorescent light fixtures to use T8 lamps and electronic ballasts, and replacement of existing incandescent and mercury vapor lighting with fluorescent and high pressure sodium lighting. See attached cost estimate for itemized breakdown of project. This work shall be performed in buildings no. 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357.	EA	1	228.7	228.7
ESTIMATED CONTRACT COST				204.528
CONTINGENCY (0%)				0
SIOH				11.924
DESIGN				12.272
TOTAL REQUEST				228.724
TOTAL REQUEST (ROUNDED)				229.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A. Retrofit 841 existing fluorescent light fixtures with electronic ballasts and T8 lamps. This will require a total of 1,682 electronic ballasts for F32T8 lamps and 3,364 F32T8 lamps. The ballasts and lamps can be purchased from the DLA. The fixtures and lenses should be cleaned while the ballasts and lamps are replaced. In some cases, it may be less expensive to replace the existing fixtures with new fixtures that already have electronic ballasts and T8 lamps. This should be determined at the time that construction bids are recieved.

B. Remove 797 existing incandescent and mercury vapor light fixtures, and replace them with 568 new fluorescent and high pressure sodium light fixtures. The fixture types and quantities required are listed on the cost estimate attached. The fluorescent fixtures should be specified with electronic ballasts and T8 lamps. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same wherever possible.

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	
Fort Bliss, Texas	

4. PROJECT TITLE	5. PROJECT NUMBER
Lighting Systems Upgrade - Project 5	

11. REQUIREMENT

The project is required to reduce lighting energy consumption at Fort Bliss facilities. The project provides more efficient interior lighting systems, in order to save lighting energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these new lighting systems will result in the following:

Electrical Savings	256,665	KWH/yr
Gas Penalty	151	MCF/yr
Total Energy Savings	725	MMBTU/yr
Cost Savings	79,987	$/yr
Payback Period	2.8	yrs
SIR	5.20	

CURRENT SITUATION:

A. The installation currently has much fluorescent lighting in it's buildings. These existing light fixtures typically have the T12 lamps and standard magnetic ballasts. The existing ballasts and lamps should be replaced with new electronic ballasts and T8 lamps, or completely new electronic fluorescent fixtures should be installed, if less expensive. These electronic fluorescent lamps and ballasts are more efficient and use less energy.

B. The facility also has numerous incandescent and mercury vapor lighting systems in it's buildings. These existing light sources are inefficient and should be replaced with more efficient light sources, such as fluorescent and high pressure sodium.

IMPACT IF NOT PROVIDED

If this project is not provided, a reduction of 725 MMBTU per year of energy and $79,987 of utility and maintenance costs will continue to be wasted. There will be no contribution to energy reduction goals established at the facility.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: BLISS
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT BLISS REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-03 EEAP LIGHTING STUDY SURVEY
FISCAL YEAR 1995 DISCRETE PORTION NAME: PROJECT5
ANALYSIS DATE: 03-17-95 ECONOMIC LIFE 20 YEARS PREPARED BY: PIEPER

1. INVESTMENT

A. CONSTRUCTION COST	$ 204528.	
B. SIOH	$ 11924.	
C. DESIGN COST	$ 12272.	
D. TOTAL COST (1A+1B+1C)	$ 228724.	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0.	
F. PUBLIC UTILITY COMPANY REBATE	$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)		$ 228724.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.46	876.	$ 5659.	15.08	$ 85337.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.27	-151.	$ -342.	18.58	$ -6363.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 59104.	14.88	$ 879468.
N. TOTAL		725.	$ 64420.		$ 958442.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 15567.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 231637.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)	$ 231637.
4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))	$ 79987.
5. SIMPLE PAYBACK PERIOD (1G/4)	2.86 YEARS
6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C)	$ 1190079.
7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= (IF < 1 PROJECT DOES NOT QUALIFY)	5.20
8. ADJUSTED INTERNAL RATE OF RETURN (AIRR):	11.85 %

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Fort Bliss, Texas, building Nos. 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2350, 2351, 2352, 2353, 2354, 2355,

PROJECT NO: 03-0185.01 **DATE:** 3/17/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: Lighting Systems Upgrade - Project 5

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing incandescent light fixtures	797	ea	1.0	10.00	7,970			7,970
Demolition of existing mercury vapor light fixtures		ea	1.0	15.00				
Miscellaneous cutting and patching of ceilings	797	ea	1.0	5.00	3,985	5.00	3,985	7,970
Miscellaneous wire, conduit and electrical parts	568	ea	1.0	5.00	2,840	5.00	2,840	5,680
Installation of new 18W fluorescent light fixtures		ea	1.0	30.00		60.00		
Installation of new 25W fluorescent light fixtures	96	ea	1.0	30.00	2,880	70.00	6,720	9,600
Installation of new 32W fluorescent light fixtures		ea	1.0	30.00		80.00		
Installation of new 2 lamp, 32W fluorescent light fixtures	398	ea	1.0	30.00	11,940	80.00	31,840	43,780
Installation of new 3 lamp, 32W fluorescent light fixtures		ea	1.0	30.00		100.00		
Installation of new 4 lamp, 32W fluorescent light fixtures	2	ea	1.0	30.00	60	100.00	200	260
Installation of new 150W, HPS lowbay fixtures	55	ea	1.0	45.00	2,475	200.00	11,000	13,475
Installation of new 200W, HPS lowbay fixtures	17	ea	1.0	45.00	765	250.00	4,250	5,015
Installation of new 400W, HPS lowbay fixtures		ea	1.0	45.00		300.00		
Installation of new lamp sockets in existing fluorescent fixtures	1,682	ea	1.0	5.00	8,410	8.00	13,456	21,866
Installation of new F32T8 electronic ballasts	1,682	ea	1.0	15.00	25,230	16.70	28,089	53,319
Installation of new F32T8 lamps and sockets	3364	ea	1.0			2.65	8,915	8,915
Installation of new F59T8 electronic ballasts		ea	1.0	15.00		29.38		
Installation of new F59T8 lamps and sockets		ea	1.0			10.27		
				SUBTOTAL	66,555		111,295	177,850
				O & P @ 20%	13,311		22,259	26,678
				SUBTOTAL	79,866		133,554	204,528
				DESIGN @ 6%				12,272
				SUBTOTAL				216,800
				SIOH @ 5.5%				11,924
				TOTAL				$228,724

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
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(817) 335-3000 * FAX (817) 335-1025

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Fort Bliss, Texas	Lighting Systems Upgrade - Project 6

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			501.1

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Conversion of existing fluorescent light fixtures to use T8 lamps and electronic ballasts, and replacement of existing incandescent and mercury vapor lighting with fluorescent and high pressure sodium lighting. See attached cost estimate for itemized breakdown of project. This work shall be performed in buildings no. 2527, 2528, 2529, 2536, 2537, 2538, 2588, 5000, 5804, 5805, 5808, 5838, 5843, 5849, 5850, 5851, 5852, 5853, 5854, 5855, 5856, 5857, 5858, 5859, 5860, 5863, 5864.	EA	1	501.1	501.1
ESTIMATED CONTRACT COST				448.127
CONTINGENCY (0%)				0
SIOH				26.126
DESIGN				26.888
TOTAL REQUEST				501.141
TOTAL REQUEST (ROUNDED)				502.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A. Retrofit 3,001 existing fluorescent light fixtures with electronic ballasts and T8 lamps. This will require a total of 5,982 electronic ballasts for F32T8 lamps, 20 electronic ballasts for F96T8 lamps, 10,999 F32T8 lamps and 40 F96T8 lamps. The ballasts and lamps can be purchased from the DLA. The fixtures and lenses should be cleaned while the ballasts and lamps are replaced. In some cases, it may be less expensive to replace the existing fixtures with new fixtures that already have electronic ballasts and T8 lamps. This should be determined at the time that construction bids are recieved.

B. Remove 632 existing incandescent and mercury vapor light fixtures, and replace them with 486 new fluorescent and high pressure sodium light fixtures. The fixture types and quantities required are listed on the cost estimate attached. The fluorescent fixtures should be specified with electronic ballasts and T8 lamps. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same wherever possible.

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		17, March, 1995

3. INSTALLATION AND LOCATION	
	Fort Bliss, Texas

4. PROJECT TITLE	5. PROJECT NUMBER
Lighting Systems Upgrade - Project 6	

11. REQUIREMENT

The project is required to reduce lighting energy consumption at Fort Bliss facilities. The project provides more efficient interior lighting systems, in order to save lighting energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these new lighting systems will result in the following:

Electrical Savings	748,315	KWH/yr
Gas Penalty	440	MCF/yr
Total Energy Savings	2,114	MMBTU/yr
Cost Savings	126,135	$/yr
Payback Period	3.9	yrs
SIR	3.74	

CURRENT SITUATION:

A. The installation currently has much fluorescent lighting in it's buildings. These existing light fixtures typically have the T12 lamps and standard magnetic ballasts. The existing ballasts and lamps should be replaced with new electronic ballasts and T8 lamps, or completely new electronic fluorescent fixtures should be installed, if less expensive. These electronic fluorescent lamps and ballasts are more efficient and use less energy.

B. The facility also has numerous incandescent and mercury vapor lighting systems in it's buildings. These existing light sources are inefficient and should be replaced with more efficient light sources, such as fluorescent and high pressure sodium.

IMPACT IF NOT PROVIDED

If this project is not provided, a reduction of 2,114 MMBTU per year of energy and $126,135 of utility and maintenance costs will continue to be wasted. There will be no contribution to energy reduction goals established at the facility.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: BLISS
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT BLISS REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-03 EEAP LIGHTING STUDY SURVEY
FISCAL YEAR 1995 DISCRETE PORTION NAME: PROJECT6
ANALYSIS DATE: 03-17-95 ECONOMIC LIFE 20 YEARS PREPARED BY: PIEPER

1. INVESTMENT

A. CONSTRUCTION COST	$ 448127.	
B. SIOH	$ 26126.	
C. DESIGN COST	$ 26888.	
D. TOTAL COST (1A+1B+1C)	$ 501141.	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0.	
F. PUBLIC UTILITY COMPANY REBATE	$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)		$ 501141.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.46	2554.	$ 16499.	15.08	$ 248803.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.27	-440.	$ -998,	18.58	$ -18541.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 86194.	14.88	$ 1282567.
N. TOTAL		2114.	$ 101695.		$ 1512828.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 24440.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 363667.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)	$ 363667.
4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))	$ 126135.
5. SIMPLE PAYBACK PERIOD (1G/4)	3.97 YEARS
6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C)	$ 1876495.
7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= (IF < 1 PROJECT DOES NOT QUALIFY)	3.74
8. ADJUSTED INTERNAL RATE OF RETURN (AIRR):	10.03 %

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Fort Bliss, Texas, building Nos. 2527, 2528, 2529, 2536, 2537, 2538, 2588, 5000, 5804, 5805, 5808, 5838, 5843, 5849, 5850, 5851, 5852, 5853, 5854, 5855, 5856, 5857, 5858, 5859, 5860, 5863, 5864

PROJECT NO: 03-0185.01 **DATE:** 3/17/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: Lighting Systems Upgrade - Project 6

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing incandescent light fixtures	606	ea	1.0	10.00	6,060			6,060
Demolition of existing mercury vapor light fixtures	27	ea	1.0	15.00	405			405
Miscellaneous cutting and patching of ceilings	633	ea	1.0	5.00	3,165	5.00	3,165	6,330
Miscellaneous wire, conduit and electrical parts	487	ea	1.0	5.00	2,435	5.00	2,435	4,870
Installation of new 18W fluorescent light fixtures	12	ea	1.0	30.00	360	60.00	720	1,080
Installation of new 25W fluorescent light fixtures	163	ea	1.0	30.00	4,890	70.00	11,410	16,300
Installation of new 32W fluorescent light fixtures		ea	1.0	30.00		80.00		
Installation of new 2 lamp, 32W fluorescent light fixtures	58	ea	1.0	30.00	1,740	80.00	4,640	6,380
Installation of new 3 lamp, 32W fluorescent light fixtures	50	ea	1.0	30.00	1,500	100.00	5,000	6,500
Installation of new 4 lamp, 32W fluorescent light fixtures	82	ea	1.0	30.00	2,460	100.00	8,200	10,660
Installation of new 150W, HPS lowbay fixtures	67	ea	1.0	45.00	3,015	200.00	13,400	16,415
Installation of new 200W, HPS lowbay fixtures	48	ea	1.0	45.00	2,160	250.00	12,000	14,160
Installation of new 400W, HPS lowbay fixtures	7	ea	1.0	45.00	315	300.00	2,100	2,415
Installation of new lamp sockets in existing fluorescent fixtures	6,002	ea	1.0	5.00	30,010	8.00	48,016	78,026
Installation of new F32T8 electronic ballasts	5,982	ea	1.0	15.00	89,730	16.70	99,899	189,629
Installation of new F32T8 lamps and sockets	10,999	ea	1.0			2.65	29,147	29,147
Installation of new F59T8 electronic ballasts	20	ea	1.0	15.00	300	29.38	588	888
Installation of new F59T8 lamps and sockets	40	ea	1.0			10.27	411	411
				SUBTOTAL	148,545		241,131	389,676
				O & P @ 20%	29,709		48,226	58,451
				SUBTOTAL	178,254		289,357	448,127
				DESIGN @ 6%				26,888
				SUBTOTAL				475,015
				SIOH @ 5.5%				26,126
				TOTAL				$501,141

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

APPENDIX A

ENERGY COST ANALYSIS

APPENDIX A
ENERGY COST ANALYSIS

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APPENDIX A
ENERGY COST ANALYSIS

A. Electrical Energy Cost Analysis

Electric Rate Schedule: Fort Bliss is supplied electrical power by the El Paso Electric Company. The Electric Co. representative for the Fort Bliss account is currently Joe Provincio, in El Paso, Texas, 915-543-5947. The facility is billed under the Military Reservation Service Rate, Schedule No. 31, which is provided, beginning on page A-2. The current monthly billing components of this rate schedule are as follows:

Demand Charge:	\$21.50/KW	for the first 10,000 KW or less of billing demand
	\$21.50/KW	for all billing demand over 10,000 KW
where:	Billing Demand is the highest 30 minute peak KW load during each month, measured between 10:00 AM and 8:00 PM, Monday through Friday, but never less than 75% of the highest billing demand, established by Fort Bliss during the previous months of May through October, nor less than 10,000 KW, whichever is greater.	
Energy Charge:	\$0.00764/KWH	
Fuel Charge:	\$0.01441/KWH.	

Avoided Costs: In order to convert electric demand and energy savings into dollar savings, the avoided costs of demand and energy are determined. These are the marginal cost savings to be realized by the facility, per unit of demand or energy saved. Using the above billing components, the *Avoided Cost of Demand* (C_D) and the *Avoided Cost of Energy* (C_E) are determined as follows:

$$C_D = \frac{\$21.50}{KW}$$

$$C_E = (E + F) \times \frac{KWH}{3413\ BTU} \times \frac{1{,}000{,}000\ BTU}{MMBTU} \qquad \frac{\$}{MMBTU}$$

where,

E = energy charge = \$0.00764/KWH
F = fuel cost factor = \$0.01441/KWH

$$C_E = (0.00764 + 0.01441) \times \frac{1{,}000{,}000}{3413} = \frac{\$6.46}{MMBTU}$$

Rebate Program: The El Paso Electric Company currently offers cash incentives for lighting retrofits, which area listed on page A-5. These incentives will be included where applicable in the ECO savings calculations in this study.

EL PASO ELECTRIC COMPANY

SCHEDULE NO. 31
MILITARY RESERVATION SERVICE RATE

APPLICABILITY

Available to United States Army for Fort Bliss Main Post Area for a minimum contract capacity of 10.000 kilowatts. All service will be taken at the point of delivery designated by the Company.

TERRITORY

El Paso County, Texas

TYPE OF SERVICE

Service will be alternating current 60 hertz, three phase at the transmission voltage of 115.000 volts.

MONTHLY RATE

Demand Charge

$21.50 per kilowatt for the first 10.000 kilowatts or less of Demand (I)

$21.50 per kilowatt for all additional kilowatts of Demand (I)

Energy Charge

$0.00764 per kilowatt-hour for all kilowatt-hours (I)

MONTHLY MINIMUM

Demand charge for the Minimum Contract Capacity of 10.000 kilowatts or the applicable minimum demand charge, whichever is greater.

DETERMINATION OF DEMAND

Maximum demand will be defined as the highest measured thirty (30) minute average kilowatt load determined by measurement. The measured demand will be adjusted for billing when the metering adjustment clause is applicable. (T)

The demand used for billing shall never be less than 75% of the highest measured on-peak demand (adjusted for metering adjustment) established during billing months May through October in the twelve (12) month period ending with the current month, nor less than the minimum contract capacity, whichever is greater. The exception to this will occur when the 1/2 on-peak - 1/2 off-peak provision is invoked. At that time, the measured billing demand shall be used for the purpose of this paragraph.

When the demand established during the off-peak period exceeds the demand established during the on-peak period, the demand used for billing will be 1/2 the on-peak period demand plus 1/2 the off-peak period demand.

On-peak period shall be from 10:00 A.M. to 8:00 P.M. Mountain Standard Time for weekdays of Monday through Friday. Off-peak period shall be all other hours of the week not covered in the on-peak period.

EL PASO ELECTRIC COMPANY

SCHEDULE NO. 31
MILITARY RESERVATION SERVICE RATE

RATING PERIOD SELECTION OPTION

Upon written request by the customer and approval by the Company. a customer may shift his 10-hour peak period for billing purposes by two (2) hours around the normally defined on-peak period. The customer may exercise this option twice during a twelve (12) month billing period.

METERED ADJUSTMENT

A. El Paso Electric Company metering equipment is installed on the low voltage (14.4 KV) side of substation transformation. therefore. for billing purposes. (1) the metered kilowatt demands shall be increased by 1.035% and (2) the metered kilowatt-hour usages shall be increased by 0.825%. For purposes of this adjustment. the Ben Milam School kilowatt demand and kilowatt-hour usage shall be subtracted from the Fort Bliss kilowatt demand and kilowatt-hour usage before the adjustment.

B. Ben Milam School. Ben Milam School is located within the Fort Bliss Military Reservation but is a school of the El Paso Independent School District. Presently. Ben Milam School is serviced through Fort Bliss facilities. To compensate Fort Bliss for this usage. El Paso Electric Company shall deduct from Fort Bliss' demand billing Ben Milam's actual measured demand and energy each month.

POWER FACTOR ADJUSTMENT

If the power factor at the time of the highest measured thirty (30) minute interval kilowatt demand for the entire plant is below 90% lagging. a charge of $0.0700 per KVAR will be made for each KVAR by which customer's computed KVAR demand exceeds 48.432% of the measured kilowatt demand. If the power factor is greater than or equal to 90%. then no power factor adjustment will be made. (T)

FIXED FUEL FACTOR

The above rates are subject to the provisions of Company's Tariff Schedule No. 98 entitled Fixed Fuel Factor.

TERMS OF PAYMENT

The due date of the bill for utility service shall not be less than sixteen (16) days after issuance. A bill becomes delinquent if not received at the Company by the due date.

TERMS AND CONDITIONS

The Company's Rules and Regulations apply to service under this schedule. The Term of Contract under this schedule shall not be less than ten (10) years.

PUBLIC UTILITY COMMISSION OF TEXAS
APPROVED
MAR 09 '92 DOCKET -9945
CONTROL # 10963
TARIFF CLERK

Section Number 1 Revision Number
Sheet Number 18 Effective with energy

SCHEDULE NO. 98
FIXED FUEL FACTOR

APPLICABILITY

Electric service billed under rate schedules having a Fixed Fuel Factor Clause shall be subject to a Fixed Fuel Factor.

TERRITORY

Texas Service Area

FORMULA

The Fixed Fuel Factors recognize loss adjustments due to different voltage levels of service:

		Energy Loss Factor	Fixed Fuel Factor ($/KWH)	
A.	Texas System	1.000000	0.01523	
B.	Transmission Voltage (If customer is not specified below and takes service and is metered at 69,000 volts and higher.)			
	Schedule No. 15	.95228	.01450	(I)(
	Schedule No. 26	.97285	.01482	(I)(
	Schedule No. 29	.94636	.01441	(I)(
	Schedule No. 30	.94636	.01441	(I)(
	Schedule No. 31	.94636	→ .01441 - ≈ 210	(I)(
C.	Primary Voltage (If customer takes service and is metered at 2,400 volts or higher but less than 69,000 volts.)	.97285	0.01482	(I)(
D.	Secondary Voltage (If customer takes service and is metered at 480 volts and below.)	1.01513	0.01546	(R)(F

PUBLIC UTILITY COMMISSION OF TEXAS
APPROVED
MAR 09 '92 DOCKET 9945 -
CONTROL # 10963
TARIFF CLERK

Table II: Eligible E-Light Technologies & Incentives

	Technologies	Incentive Amount
1	Optical Reflectors 4-ft 4 lamp fixture	$12.50/fixture delamp
2	Optical Reflectors 8-ft 2 lamp fixture	$11.75/fixture delamp
3	Optical Reflectors 2x2-ft 2 lamp fixture	$6.25/fixture delamp
4	Halogen PAR replacing incandescent	$0.75/lamp removed
5	Exit Sign Conversion to Incandescent	$1.25/2 lamp removed
6	Compact Fluorescent Lamp	$1.50/lamp removed
7	HID Replacing Fluorescent (indoor only)	$129.00/peak kW avoided

B. Natural Gas Energy Cost Analysis

Gas Service Contract: Fort Bliss is currently supplied natural gas for process and heating by Southern Union Gas Company, based in El Paso, Texas. The current contract calls for the billing amount to be figured monthly, based on a special transportation rate. This contract is described by Southern Union Gas on page A-7, which has included the transportation rate history for the 1994 calendar year.

Avoided Cost: In order to convert gas energy savings or penalties into cost savings or penalties, the *Avoided Cost of Gas* (C_G) is determined. Since the gas costs vary monthly as described above, the avoided cost of gas energy will be determined by averaging the billing history provided by Southern Union Gas on page A-7 as follows:

$$C_G = (Trans.\ Rate) + (Avg.\ Cost\ of\ Gas) \quad \frac{\$}{MCF}$$

where,

Avg. Cost of Gas[1] = $1.983 per MCF
Transportation Rate = $0.285 per MCF

$$C_G = (0.285 + 1.983) = 2.268 \frac{\$}{MCF}$$

Southern
Union Gas

P.O. Box 2040, El Paso, Texas 79976-0001 (915) 544-6300

December 22, 1994

Mr. Chris Pieper
Huitt Zollars

RE: Lighting & Energy Study for Fort Bliss

Dear Mr. Pieper:

You requested that we provide you with the Tariff rate, for Fort Bliss, for natural gas. Fort Bliss is on a special transportation rate of $.285 per MCF at 14.9 psia plus the cost of gas which all classes of customers pay. What follows is a summary table of the cost of gas for the past 12 months. A recent rate sheet is attached.

MONTH/YEAR	COST OF GAS/MCF
January 1994	$2.298
February 1994	$2.330
March 1994	$2.286
April 1994	$2.286
May 1994	$2.062
June 1994	$1.783
July 1994	$1.783
August 1994	$1.783
September 1994	$1.925
October 1994	$1.770
November 1994	$1.769
December 1994	$1.721

We hope this is the information you were looking for to complete your energy study for Ft. Bliss. If we can be of further assistance please do not hesitate to call me at 915/521-4502.

Sincerely Yours,

SOUTHERN UNION GAS COMPANY

Clifford Finley, P.E.
Sales Manager

CF:vp
Attachment

REFERENCES

1. Avg Cost = (2.298+2.330+2.286+2.286+2.062+1.783+1.783+1.783+1.925+1.770+1.769+1.721)/12 = 1.983

APPENDIX B

DETAILED CALCULATIONS

APPENDIX B
DETAILED CALCULATIONS

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APPENDIX B
DETAILED CALCULATIONS

A. Annual Heating and Cooling Percentage Calculations

The percentage of the year that the building's heating systems are in operation (H_H) and the percentage of the year that the building's cooling systems are in operation (H_C) were determined to be used in the heating energy penalty and the cooling energy savings calculations. For the purposes of this study, all building heating systems are assumed to operate whenever the outside air temperature is below 60 F and all building cooling systems are assumed to operate whenever the outside air temperature is above 70 F. These annual hours were obtained from Engineering Weather Data, TM 5-785. The weather data in this technical manual with the closest proximity to Fort Bliss was obtained from Brownsville IAP, Texas. This data showed an annual total of 1,189 hours below 60 F and 5,993 hours above 70 F. Using these figures, the values of H_H and H_C were determined as follows:

$$\therefore \quad H_H = \frac{1{,}189\ hrs}{8{,}760\ hrs} = 0.13 \qquad H_C = \frac{5{,}993\ hrs}{8{,}760\ hrs} = 0.68$$

B. Heating and Cooling System Efficiencies

In order to calculate the heating energy penalties and cooling energy savings, the heating and cooling system efficiencies were estimated. The buildings surveyed had various types of cooling and heating systems as is shown on the Building Data Sheets in Appendix G. The most common type of cooling system was the simple evaporative cooler. The heating systems ranged from gas fired unit heaters, to gas fired furnaces, to small hot water hydronic systems. The ages of these HVAC systems also varied greatly from building to building.

In order to simplify the calculations, all cooling systems will be assumed to have an Energy Efficiency Ratio (EER) of 30 BTU/W-hr, and all gas fired heating systems will be assumed to have an efficiency (EFF_H) of 70%. These values will be used in the savings calculations as follows:

$$EER = \frac{30\ BTU}{W\text{-}hr} \qquad EFF_H = 0.70$$

C. Annual Hours of Lighting Operation

The operational buildings of Fort Bliss are operated basically 4 days per week, and 10 hours per day. However, in the storage buildings, which are basically the 1100s and the 2300s, the lighting is used less than 40 hours per week. The facility is operational year round, 52 weeks per year. For the purposes of this study, the annual Lighting Operational Period (H) for all buildings except the 1100 and 2300 series is calculated as follows:

Assumptions:

10 hrs per day
4 days per week
52 weeks per year

$$H = \frac{10\ hrs}{day} \times \frac{4\ days}{week} \times \frac{52\ wks}{yr} = \frac{2{,}080\ hrs}{yr}$$

For the 1100 and 2300 series of buildings, the annual lighting operational period is calculated as follows:

Assumptions:

5 hrs per day
4 days per week
52 weeks per year

$$H = \frac{5\ hrs}{day} \times \frac{4\ days}{week} \times \frac{52\ wks}{yr} = \frac{1{,}040\ hrs}{yr}$$

D. Total Lighting Energy Consumption

The total annual lighting energy consumption for Fort Bliss was computed to be used as a yardstick against calculated ECO energy savings. The data for this calculation were taken from the data sheets included in Appendix G. First, the total number of each different type of light fixture was counted for each building. These numbers are presented on pages B-4 to B-9 . Next, using the input wattage of each fixture and the total count for each building, the lighting loads for each building were calculated on pages B-10 to B-15 . Finally, using the calculated lighting loads, the annual lighting operational periods and the number of duplicate buildings, the total annual lighting energy consumption was calculated for the buildings included in this study, see page B-16. The following sample calculation illustrates the procedure used.

Sample Calculation: Building #11

(a) Lighting Load for 4 Lamp, F40, Lay-in Fixtures: (see page B-10)

Assumptions:

Quantity of 4 lamp, F40, lay-in fixtures[1] = 24
Input wattage[2] = 192 watts per fixture

$$24\ fixtures \times \frac{192\ watts}{fixture} = 4{,}608\ watts$$

(b) Total Lighting Load (L) for Building #11: (see page B-10)

$$L = 15{,}094\ watts$$

(c) Annual Lighting KWH for Building #11:

Assumptions:

Lighting Period[3] = 2,080 hrs/yr

$$15{,}094\ watts \times \frac{2{,}080\ hrs}{yr} \times \frac{1\ KW}{1{,}000\ watts} = 31{,}396\ \frac{KWH}{yr}$$

(d) Total Annual KWH for Building #11 and All Similar Buildings: (see page B-16)

Assumptions:

No. of Similar Buildings = 5

$$\frac{31{,}396\ KWH}{yr} \times (\ 1\ unique\ +\ 5\ similar\ ) = 188{,}376\ \frac{KWH}{yr}$$

Based on the building by building calculations as demonstrated above, the total annual lighting energy for the buildings studied was determined as follows:

$$Total\ Annual\ Lighting\ Energy = 4{,}990{,}613\ \frac{KWH}{yr}$$

In unit of energy (BTUs), this is as follows:

$$\frac{4{,}990{,}613\ KWH}{yr} \times \frac{3{,}413\ BTU}{KWH} \times \frac{1\ MMBTU}{1{,}000{,}000\ BTU} = 17{,}032.9\ \frac{MMBTU}{yr}$$

Divided between the 12 months of the year, this is as follows:

$$\frac{4{,}990{,}613\ KWH}{yr} \times \frac{1\ yr}{12\ mos} = 415{,}884\ \frac{KWH}{mo}$$

REFERENCES

1. From ECO Data Sheets, see Appendix G.
2. Per Advance ballasts manufacturer's data for 2, 2 lamp ballasts with F40 fluorescent lamps.
3. From Annual Lighting Operational Period Calculation, Appendix B.

LIGHT FIXTURE TYPE	FIXTURE QUANTITY BUILDING NUMBER									
	1	8	11	12	13	51	54	55	56	58
4 LAMP, F40, LAY-IN	142		24	12	74	58	36	47	98	86
4 LAMP, F40, POLYWRAP	25		19	21	10		1	4		
4 LAMP, F40, LOUVERED	0	33			53				15	
4 LAMP, F40, INDUSTRIAL			20		0				12	2
3 LAMP, F40, LOUVERED		6			0				18	
3 LAMP, F40, INDUSTRIAL										
2 LAMP, F40, LAY-IN	10				17					
2 LAMP, F40, POLYWRAP	5		8	14	5		13		13	
2 LAMP, F40, LOUVERED	13	25		5	19			16	54	17
2 LAMP, F40, INDUSTRIAL							1	1	20	13
1 LAMP, F40, POLYWRAP	1									
1 LAMP, F40, LOUVERED									27	
1 LAMP, F40, INDUSTRIAL										
4 LAMP, F96-75W, INDUSTRIAL										
3 LAMP, F96-75W, INDUSTRIAL										
2 LAMP, F96-215W, LOUVERED					10					
2 LAMP, F96-110W, LOUVERED					19				6	
2 LAMP, F96-75W, LOUVERED	20			18	10					9
1 LAMP, F96-215W, LOUVERED										
1 LAMP, F96-110W, LOUVERED										
1 LAMP, F96-75W, INDUSTRIAL				1			11			45
2 LAMP, F40U, 2x2, LAY-IN	5				24					
1 LAMP, 400W-MH, HID										
1 LAMP, 400W-MVR, MERC.										
2 LAMP, 1000W, QUARTZ										
1 LAMP, 500W-PS, SOCKET						29		7	5	
1 LAMP, 250W-MVR, MERC.										
1 LAMP, 300W-PS, SOCKET						2				
1 LAMP, 200W-PS, SOCKET				2			3			25
1 LAMP, 150W-A21, SOCKET			10	15		4	6	6	2	
1 LAMP, 100W-A19, SOCKET	8	2	8	13	18			2	16	3
1 LAMP, 60W-A19, SOCKET	17	15	2	11		2			16	29
1 LAMP, 40W, SOCKET					12		3			

LIGHT FIXTURE TYPE	FIXTURE QUANTITY BUILDING NUMBER									
	111	311	500	512	720	722	723	724	725	762
4 LAMP, F40, LAY-IN	2	3	143	29			70	24	73	
4 LAMP, F40, POLYWRAP	34		19	125						30
4 LAMP, F40, LOUVERED	82		375	87		8			60	
4 LAMP, F40, INDUSTRIAL										
3 LAMP, F40, LOUVERED										
3 LAMP, F40, INDUSTRIAL										
2 LAMP, F40, LAY-IN		1								
2 LAMP, F40, POLYWRAP	22	23		34		22	83	1	9	234
2 LAMP, F40, LOUVERED	6		2	109	172			24		
2 LAMP, F40, INDUSTRIAL							12	12	16	
1 LAMP, F40, POLYWRAP	10								4	
1 LAMP, F40, LOUVERED										
1 LAMP, F40, INDUSTRIAL		20		1						
4 LAMP, F96-75W, INDUSTRIAL										
3 LAMP, F96-75W, INDUSTRIAL						12				
2 LAMP, F96-215W, LOUVERED	8									
2 LAMP, F96-110W, LOUVERED	36						44			
2 LAMP, F96-75W, LOUVERED						2		44		
1 LAMP, F96-215W, LOUVERED	3									
1 LAMP, F96-110W, LOUVERED	7									
1 LAMP, F96-75W, INDUSTRIAL				1						
2 LAMP, F40U, 2x2, LAY-IN										
1 LAMP, 400W-MH, HID										
1 LAMP, 400W-MVR, MERC.										
2 LAMP, 1000W, QUARTZ										
1 LAMP, 500W-PS, SOCKET						29		7	5	
1 LAMP, 250W-MVR, MERC.										
1 LAMP, 300W-PS, SOCKET						2				
1 LAMP, 200W-PS, SOCKET	2		5	1	4					2
1 LAMP, 150W-A21, SOCKET			10	15		4	6	6	2	
1 LAMP, 100W-A21, SOCKET	12	29	3	49	1	2	8	8	42	
1 LAMP, 60W-A19, SOCKET	13	7	24	13						
1 LAMP, 40W, SOCKET		22	1	8						

LIGHT FIXTURE TYPE	FIXTURE QUANTITY BUILDING NUMBER									
	769	738	746	754	1101	1102	1105	1106	1178	1270
4 LAMP, F40, LAY-IN	16						60	4		
4 LAMP, F40, POLYWRAP				2	13			5		51
4 LAMP, F40, LOUVERED				8	21	30				
4 LAMP, F40, INDUSTRIAL								3		
3 LAMP, F40, LOUVERED										
3 LAMP, F40, INDUSTRIAL										
2 LAMP, F40, LAY-IN										
2 LAMP, F40, POLYWRAP	3	12	34							
2 LAMP, F40, LOUVERED		28	12							
2 LAMP, F40, INDUSTRIAL	12									
1 LAMP, F40, POLYWRAP	15									
1 LAMP, F40, LOUVERED										
1 LAMP, F40, INDUSTRIAL										
4 LAMP, F96-75W, INDUSTRIAL	56					2				
3 LAMP, F96-75W, INDUSTRIAL										
2 LAMP, F96-215W, LOUVERED										
2 LAMP, F96-110W, LOUVERED		87	87							
2 LAMP, F96-75W, LOUVERED				24	4			13		
1 LAMP, F96-215W, LOUVERED										
1 LAMP, F96-110W, LOUVERED										
1 LAMP, F96-75W, INDUSTRIAL										
2 LAMP, F40U, 2x2, LAY-IN										
1 LAMP, 400W-MH, HID										
1 LAMP, 400W-MVR, MERC.										
2 LAMP, 1000W, QUARTZ										
1 LAMP, 500W-PS, SOCKET				29				4		
1 LAMP, 250W-MVR, MERC.								6		
1 LAMP, 300W-PS, SOCKET										
1 LAMP, 200W-PS, SOCKET					16		10	12	26	
1 LAMP, 150W-A21, SOCKET		6	6	2	1					1
1 LAMP, 100W-A21, SOCKET		8	8	2	2	1				1
1 LAMP, 60W-A19, SOCKET	25				2		4			
1 LAMP, 40W, SOCKET										

LIGHT FIXTURE TYPE	FIXTURE QUANTITY BUILDING NUMBER									
	1271	2322	2320	2333	2354	2527	2528	2529	2536	2588
4 LAMP, F40, LAY-IN						31				
4 LAMP, F40, POLYWRAP			5			8				
4 LAMP, F40, LOUVERED						85				10
4 LAMP, F40, INDUSTRIAL								24		3
3 LAMP, F40, LOUVERED						67				104
3 LAMP, F40, INDUSTRIAL						255				
2 LAMP, F40, LAY-IN										
2 LAMP, F40, POLYWRAP		1		17	8	19	8	74	10	
2 LAMP, F40, LOUVERED						11				180
2 LAMP, F40, INDUSTRIAL				75						133
1 LAMP, F40, POLYWRAP										
1 LAMP, F40, LOUVERED						64				
1 LAMP, F40, INDUSTRIAL										38
4 LAMP, F96-75W, INDUSTRIAL										
3 LAMP, F96-75W, INDUSTRIAL										
2 LAMP, F96-215W, LOUVERED										
2 LAMP, F96-110W, LOUVERED					32					48
2 LAMP, F96-75W, LOUVERED	22									10
1 LAMP, F96-215W, LOUVERED										
1 LAMP, F96-110W, LOUVERED										
1 LAMP, F96-75W, INDUSTRIAL										
2 LAMP, F40U, 2x2, LAY-IN										
1 LAMP, 400W-MH, HID										
1 LAMP, 400W-MVR, MERC.										
2 LAMP, 1000W, QUARTZ								4		
1 LAMP, 500W-PS, SOCKET		29					15		21	122
1 LAMP, 250W-MVR, MERC.										
1 LAMP, 300W-PS, SOCKET		33	27	1		21	28			40
1 LAMP, 200W-PS, SOCKET								46	2	16
1 LAMP, 150W-A21, SOCKET					1			4		36
1 LAMP, 100W-A21, SOCKET		1	1	5	1	1		4		15
1 LAMP, 60W-A19, SOCKET			1			12				3
1 LAMP, 40W, SOCKET						17				

LIGHT FIXTURE TYPE	FIXTURE QUANTITY BUILDING NUMBER									
	5000	5804	5805	5808	5838	5849	5852	5854	5855	5858
4 LAMP, F40, LAY-IN		94	38	29	109	74	42	88	72	
4 LAMP, F40, POLYWRAP	12	32		54			25			
4 LAMP, F40, LOUVERED										
4 LAMP, F40, INDUSTRIAL										
3 LAMP, F40, LOUVERED	4						2			41
3 LAMP, F40, INDUSTRIAL										
2 LAMP, F40, LAY-IN		5				4				
2 LAMP, F40, POLYWRAP	3	20	24	30	4	9	2	6		
2 LAMP, F40, LOUVERED										
2 LAMP, F40, INDUSTRIAL		8	12							
1 LAMP, F40, POLYWRAP		40		20	2					
1 LAMP, F40, LOUVERED										
1 LAMP, F40, INDUSTRIAL	48									
4 LAMP, F96-75W, INDUSTRIAL										
3 LAMP, F96-75W, INDUSTRIAL										
2 LAMP, F96-215W, LOUVERED										
2 LAMP, F96-110W, LOUVERED										
2 LAMP, F96-75W, LOUVERED										
1 LAMP, F96-215W, LOUVERED										
1 LAMP, F96-110W, LOUVERED										
1 LAMP, F96-75W, INDUSTRIAL										
2 LAMP, F40U, 2x2, LAY-IN										
1 LAMP, 400W-MH, HID				27						
1 LAMP, 400W-MVR, MERC.		9	18							
2 LAMP, 1000W, QUARTZ										
1 LAMP, 500W-PS, SOCKET										
1 LAMP, 250W-MVR, MERC.										
1 LAMP, 300W-PS, SOCKET										
1 LAMP, 200W-PS, SOCKET				4						
1 LAMP, 150W-A21, SOCKET	35									10
1 LAMP, 100W-A21, SOCKET	33			6		7				7
1 LAMP, 60W-A19, SOCKET	8					2	10	1	1	
1 LAMP, 40W, SOCKET										

LIGHT FIXTURE TYPE	FIXTURE QUANTITY BUILDING NUMBER									
	5859	5863								
4 LAMP, F40, LAY-IN	30									
4 LAMP, F40, POLYWRAP		58								
4 LAMP, F40, LOUVERED										
4 LAMP, F40, INDUSTRIAL										
3 LAMP, F40, LOUVERED										
3 LAMP, F40, INDUSTRIAL										
2 LAMP, F40, LAY-IN	1									
2 LAMP, F40, POLYWRAP	4									
2 LAMP, F40, LOUVERED										
2 LAMP, F40, INDUSTRIAL	52									
1 LAMP, F40, POLYWRAP		14								
1 LAMP, F40, LOUVERED										
1 LAMP, F40, INDUSTRIAL										
4 LAMP, F96-75W, INDUSTRIAL										
3 LAMP, F96-75W, INDUSTRIAL										
2 LAMP, F96-215W, LOUVERED										
2 LAMP, F96-110W, LOUVERED										
2 LAMP, F96-75W, LOUVERED										
1 LAMP, F96-215W, LOUVERED										
1 LAMP, F96-110W, LOUVERED										
1 LAMP, F96-75W, INDUSTRIAL										
2 LAMP, F40U, 2x2, LAY-IN										
1 LAMP, 400W-MH, HID										
1 LAMP, 400W-MVR, MERC.										
2 LAMP, 1000W, QUARTZ										
1 LAMP, 500W-PS, SOCKET										
1 LAMP, 250W-MVR, MERC.										
1 LAMP, 300W-PS, SOCKET										
1 LAMP, 200W-PS, SOCKET										
1 LAMP, 150W-A21, SOCKET	1									
1 LAMP, 100W-A21, SOCKET		1								
1 LAMP, 60W-A19, SOCKET		3								
1 LAMP, 40W, SOCKET										

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	TOTAL FIXTURE WATTS BUILDING NUMBER									
		1	8	11	12	13	51	54	55	56	58
4 LAMP, F40, LAY-IN	192	27,264	0	4,608	2,304	14,208	11,136	6,912	9,024	18,816	16,512
4 LAMP, F40, POLYWRAP	182	4,550	0	3,458	3,822	1,820	0	182	728	0	0
4 LAMP, F40, LOUVERED	192	0	6,336	0	0	10,176	0	0	0	2,880	0
4 LAMP, F40, INDUSTRIAL	192	0	0	3,840	0	0	0	0	0	2,304	384
3 LAMP, F40, LOUVERED	144	0	864	0	0	0	0	0	0	2,592	0
3 LAMP, F40, INDUSTRIAL	144	0	0	0	0	0	0	0	0	0	0
2 LAMP, F40, LAY-IN	96	960	0	0	0	1,632	0	0	0	0	0
2 LAMP, F40, POLYWRAP	96	480	0	768	1,344	480	0	1,248	0	1,248	0
2 LAMP, F40, LOUVERED	96	1,248	2,400	0	480	1,824	0	0	1,536	5,184	1,632
2 LAMP, F40, INDUSTRIAL	96	0	0	0	0	0	0	96	96	1,920	1,248
1 LAMP, F40, POLYWRAP	48	48	0	0	0	0	0	0	0	0	0
1 LAMP, F40, LOUVERED	48	0	0	0	0	0	0	0	0	1,296	0
1 LAMP, F40, INDUSTRIAL	48	0	0	0	0	0	0	0	0	0	0
4 LAMP, F96-75W, INDUSTRIAL	360	0	0	0	0	0	0	0	0	0	0
3 LAMP, F96-75W, INDUSTRIAL	270	0	0	0	0	0	0	0	0	0	0
2 LAMP, F96-215W, LOUVERED	516	0	0	0	0	5,160	0	0	0	0	0
2 LAMP, F96-110W, LOUVERED	264	0	0	0	0	5,016	0	0	0	1,584	0
2 LAMP, F96-75W, LOUVERED	180	3,600	0	0	3,240	1,800	0	0	0	0	1,620
1 LAMP, F96-215W, LOUVERED	258	0	0	0	0	0	0	0	0	0	0
1 LAMP, F96-110W, LOUVERED	132	0	0	0	0	0	0	0	0	0	0
1 LAMP, F96-75W, INDUSTRIAL	90	0	0	0	90	0	0	990	0	0	4,050
2 LAMP, F40U, 2x2, LAY-IN	96	480	0	0	0	2,304	0	0	0	0	0
1 LAMP, 400W-MH, HID	480	0	0	0	0	0	0	0	0	0	0
1 LAMP, 400W-MVR, MERC.	480	0	0	0	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	2,000	0	0	0	0	0	0	0	0	0	0
1 LAMP, 500W-PS, SOCKET	500	0	0	0	0	0	14,500	0	3,500	2,500	0
1 LAMP, 250W-MVR, MERC.	300	0	0	0	0	0	0	0	0	0	0
1 LAMP, 300W-PS, SOCKET	300	0	0	0	0	0	600	0	0	0	0
1 LAMP, 200W-PS, SOCKET	200	0	0	0	400	0	0	600	0	0	5,000
1 LAMP, 150W-A21, SOCKET	150	0	0	1,500	2,250	0	600	900	900	300	0
1 LAMP, 100W-A19, SOCKET	100	800	200	800	1,300	1,800	0	0	200	1,600	300
1 LAMP, 60W-A19, SOCKET	60	1,020	900	120	660	0	120	0	0	960	1,740
1 LAMP, 40W, SOCKET	40	0	0	0	0	480	0	120	0	0	0
BUILDING TOTALS		40,450	10,700	15,094	15,890	46,700	26,956	11,048	15,984	43,184	32,486

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	TOTAL FIXTURE WATTS BUILDING NUMBER									
		111	311	500	512	720	722	723	724	725	762
4 LAMP, F40, LAY-IN	192	384	576	27,456	5,568	0	0	13,440	4,608	14,016	0
4 LAMP, F40, POLYWRAP	182	6,188	0	3,458	22,750	0	0	0	0	0	5,460
4 LAMP, F40, LOUVERED	192	15,744	0	72,000	16,704	0	1,536	0	0	11,520	0
4 LAMP, F40, INDUSTRIAL	192	0	0	0	0	0	0	0	0	0	0
3 LAMP, F40, LOUVERED	144	0	0	0	0	0	0	0	0	0	0
3 LAMP, F40, INDUSTRIAL	144	0	0	0	0	0	0	0	0	0	0
2 LAMP, F40, LAY-IN	96	0	96	0	0	0	0	0	0	0	0
2 LAMP, F40, POLYWRAP	96	2,112	2,208	0	3,264	0	2,112	7,968	96	864	22,464
2 LAMP, F40, LOUVERED	96	576	0	192	10,464	16,512	0	0	2,304	0	0
2 LAMP, F40, INDUSTRIAL	96	0	0	0	0	0	0	1,152	1,152	1,536	0
1 LAMP, F40, POLYWRAP	48	480	0	0	0	0	0	0	0	192	0
1 LAMP, F40, LOUVERED	48	0	0	0	0	0	0	0	0	0	0
1 LAMP, F40, INDUSTRIAL	48	0	960	0	48	0	0	0	0	0	0
4 LAMP, F96-75W, INDUSTRIAL	360	0	0	0	0	0	0	0	0	0	0
3 LAMP, F96-75W, INDUSTRIAL	270	0	0	0	0	0	3,240	0	0	0	0
2 LAMP, F96-215W, LOUVERED	516	4,128	0	0	0	0	0	0	0	0	0
2 LAMP, F96-110W, LOUVERED	264	9,504	0	0	0	0	0	11,616	0	0	0
2 LAMP, F96-75W, LOUVERED	180	0	0	0	0	0	360	0	7,920	0	0
1 LAMP, F96-215W, LOUVERED	258	774	0	0	0	0	0	0	0	0	0
1 LAMP, F96-110W, LOUVERED	132	924	0	0	0	0	0	0	0	0	0
1 LAMP, F96-75W, INDUSTRIAL	90	0	0	0	90	0	0	0	0	0	0
2 LAMP, F40U, 2x2, LAY-IN	96	0	0	0	0	0	0	0	0	0	0
1 LAMP, 400W-MH, HID	480	0	0	0	0	0	0	0	0	0	0
1 LAMP, 400W-MVR, MERC.	480	0	0	0	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	2,000	0	0	0	0	0	0	0	0	0	0
1 LAMP, 500W-PS, SOCKET	500	0	0	0	0	0	14,500	0	3,500	2,500	0
1 LAMP, 250W-MVR, MERC.	300	0	0	0	0	0	0	0	0	0	0
1 LAMP, 300W-PS, SOCKET	300	0	0	0	0	0	600	0	0	0	0
1 LAMP, 200W-PS, SOCKET	200	400	0	1,000	200	800	0	0	0	0	400
1 LAMP, 150W-A21, SOCKET	150	0	0	1,500	2,250	0	600	900	900	300	0
1 LAMP, 100W-A21, SOCKET	100	1,200	2,900	300	4,900	100	200	800	800	4,200	0
1 LAMP, 60W-A19, SOCKET	60	780	420	1,440	780	0	0	0	0	0	0
1 LAMP, 40W, SOCKET	40	0	880	40	320	0	0	0	0	0	0
BUILDING TOTALS		43,194	8,040	107,386	67,338	17,412	23,148	35,876	21,280	35,128	28,324

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	TOTAL FIXTURE WATTS BUILDING NUMBER									
		769	738	746	754	1,101	1,102	1,105	1,106	1,178	1,270
4 LAMP, F40, LAY-IN	192	3,072	0	0	0	0	0	11,520	768	0	0
4 LAMP, F40, POLYWRAP	182	0	0	0	364	2,366	0	0	910	0	9,282
4 LAMP, F40, LOUVERED	192	0	0	0	1,536	4,032	5,760	0	0	0	0
4 LAMP, F40, INDUSTRIAL	192	0	0	0	0	0	0	0	576	0	0
3 LAMP, F40, LOUVERED	144	0	0	0	0	0	0	0	0	0	0
3 LAMP, F40, INDUSTRIAL	144	0	0	0	0	0	0	0	0	0	0
2 LAMP, F40, LAY-IN	96	0	0	0	0	0	0	0	0	0	0
2 LAMP, F40, POLYWRAP	96	288	1,152	3,264	0	0	0	0	0	0	0
2 LAMP, F40, LOUVERED	96	0	2,688	1,152	0	0	0	0	0	0	0
2 LAMP, F40, INDUSTRIAL	96	1,152	0	0	0	0	0	0	0	0	0
1 LAMP, F40, POLYWRAP	48	720	0	0	0	0	0	0	0	0	0
1 LAMP, F40, LOUVERED	48	0	0	0	0	0	0	0	0	0	0
1 LAMP, F40, INDUSTRIAL	48	0	0	0	0	0	0	0	0	0	0
4 LAMP, F96-75W, INDUSTRIAL	360	20,160	0	0	0	0	720	0	0	0	0
3 LAMP, F96-75W, INDUSTRIAL	270	0	0	0	0	0	0	0	0	0	0
2 LAMP, F96-215W, LOUVERED	516	0	0	0	0	0	0	0	0	0	0
2 LAMP, F96-110W, LOUVERED	264	0	22,968	22,968	0	0	0	0	0	0	0
2 LAMP, F96-75W, LOUVERED	180	0	0	0	4,320	720	0	0	2,340	0	0
1 LAMP, F96-215W, LOUVERED	258	0	0	0	0	0	0	0	0	0	0
1 LAMP, F96-110W, LOUVERED	132	0	0	0	0	0	0	0	0	0	0
1 LAMP, F96-75W, INDUSTRIAL	90	0	0	0	0	0	0	0	0	0	0
2 LAMP, F40U, 2x2, LAY-IN	96	0	0	0	0	0	0	0	0	0	0
1 LAMP, 400W-MH, HID	480	0	0	0	0	0	0	0	0	0	0
1 LAMP, 400W-MVR, MERC.	480	0	0	0	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	2,000	0	0	0	0	0	0	0	0	0	0
1 LAMP, 500W-PS, SOCKET	500	0	0	0	14,500	0	0	0	2,000	0	0
1 LAMP, 250W-MVR, MERC.	300	0	0	0	0	0	0	0	1,800	0	0
1 LAMP, 300W-PS, SOCKET	300	0	0	0	0	0	0	0	0	0	0
1 LAMP, 200W-PS, SOCKET	200	0	0	0	0	3,200	0	2,000	2,400	5,200	0
1 LAMP, 150W-A21, SOCKET	150	0	900	900	300	150	0	0	0	0	150
1 LAMP, 100W-A21, SOCKET	100	0	800	800	200	200	100	0	0	0	100
1 LAMP, 60W-A19, SOCKET	60	1,500	0	0	0	120	0	240	0	0	0
1 LAMP, 40W, SOCKET	40	0	0	0	0	0	0	0	0	0	0
BUILDING TOTALS		26,892	28,508	29,084	21,220	10,788	6,580	13,760	10,794	5,200	9,532

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	TOTAL FIXTURE WATTS BUILDING NUMBER									
		1,271	2,322	2,320	2,333	2,354	2,527	2,528	2,529	2,536	2,588
4 LAMP, F40, LAY-IN	192	0	0	0	0	0	5,952	0	0	0	0
4 LAMP, F40, POLYWRAP	182	0	0	910	0	0	1,456	0	0	0	0
4 LAMP, F40, LOUVERED	192	0	0	0	0	0	16,320	0	0	0	1,920
4 LAMP, F40, INDUSTRIAL	192	0	0	0	0	0	0	0	4,608	0	576
3 LAMP, F40, LOUVERED	144	0	0	0	0	0	9,648	0	0	0	14,976
3 LAMP, F40, INDUSTRIAL	144	0	0	0	0	0	36,720	0	0	0	0
2 LAMP, F40, LAY-IN	96	0	0	0	0	0	0	0	0	0	0
2 LAMP, F40, POLYWRAP	96	0	96	0	1,632	768	1,824	768	7,104	960	0
2 LAMP, F40, LOUVERED	96	0	0	0	0	0	1,056	0	0	0	17,280
2 LAMP, F40, INDUSTRIAL	96	0	0	0	7,200	0	0	0	0	0	12,768
1 LAMP, F40, POLYWRAP	48	0	0	0	0	0	0	0	0	0	0
1 LAMP, F40, LOUVERED	48	0	0	0	0	0	3,072	0	0	0	0
1 LAMP, F40, INDUSTRIAL	48	0	0	0	0	0	0	0	0	0	1,824
4 LAMP, F96-75W, INDUSTRIAL	360	0	0	0	0	0	0	0	0	0	0
3 LAMP, F96-75W, INDUSTRIAL	270	0	0	0	0	0	0	0	0	0	0
2 LAMP, F96-215W, LOUVERED	516	0	0	0	0	0	0	0	0	0	0
2 LAMP, F96-110W, LOUVERED	264	0	0	0	0	8,448	0	0	0	0	12,672
2 LAMP, F96-75W, LOUVERED	180	3,960	0	0	0	0	0	0	0	0	1,800
1 LAMP, F96-215W, LOUVERED	258	0	0	0	0	0	0	0	0	0	0
1 LAMP, F96-110W, LOUVERED	132	0	0	0	0	0	0	0	0	0	0
1 LAMP, F96-75W, INDUSTRIAL	90	0	0	0	0	0	0	0	0	0	0
2 LAMP, F40U, 2x2, LAY-IN	96	0	0	0	0	0	0	0	0	0	0
1 LAMP, 400W-MH, HID	480	0	0	0	0	0	0	0	0	0	0
1 LAMP, 400W-MVR, MERC.	480	0	0	0	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	2,000	0	0	0	0	0	0	0	8,000	0	0
1 LAMP, 500W-PS, SOCKET	500	0	14,500	0	0	0	0	7,500	0	10,500	61,000
1 LAMP, 250W-MVR, MERC.	300	0	0	0	0	0	0	0	0	0	0
1 LAMP, 300W-PS, SOCKET	300	0	9,900	8,100	300	0	6,300	8,400	0	0	12,000
1 LAMP, 200W-PS, SOCKET	200	0	0	0	0	0	0	0	9,200	400	3,200
1 LAMP, 150W-A21, SOCKET	150	0	0	0	0	150	0	0	600	0	5,400
1 LAMP, 100W-A21, SOCKET	100	0	100	100	500	100	100	0	400	0	1,500
1 LAMP, 60W-A19, SOCKET	60	0	0	60	0	0	720	0	0	0	180
1 LAMP, 40W, SOCKET	40	0	0	0	0	0	680	0	0	0	0
BUILDING TOTALS		3,960	24,596	9,170	9,632	9,466	83,848	16,668	29,912	11,860	147,096

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	TOTAL FIXTURE WATTS BUILDING NUMBER									
		5,000	5,804	5,805	5,808	5,838	5,849	5,852	5,854	5,855	5,858
4 LAMP, F40, LAY-IN	192	0	18,048	7,296	5,568	20,928	14,208	8,064	16,896	13,824	0
4 LAMP, F40, POLYWRAP	182	2,184	5,824	0	9,828	0	0	4,550	0	0	0
4 LAMP, F40, LOUVERED	192	0	0	0	0	0	0	0	0	0	0
4 LAMP, F40, INDUSTRIAL	192	0	0	0	0	0	0	0	0	0	0
3 LAMP, F40, LOUVERED	144	576	0	0	0	0	0	288	0	0	5,904
3 LAMP, F40, INDUSTRIAL	144	0	0	0	0	0	0	0	0	0	0
2 LAMP, F40, LAY-IN	96	0	480	0	0	0	384	0	0	0	0
2 LAMP, F40, POLYWRAP	96	288	1,920	2,304	2,880	384	864	192	576	0	0
2 LAMP, F40, LOUVERED	96	0	0	0	0	0	0	0	0	0	0
2 LAMP, F40, INDUSTRIAL	96	0	768	1,152	0	0	0	0	0	0	0
1 LAMP, F40, POLYWRAP	48	0	1,920	0	960	96	0	0	0	0	0
1 LAMP, F40, LOUVERED	48	0	0	0	0	0	0	0	0	0	0
1 LAMP, F40, INDUSTRIAL	48	2,304	0	0	0	0	0	0	0	0	0
4 LAMP, F96-75W, INDUSTRIAL	360	0	0	0	0	0	0	0	0	0	0
3 LAMP, F96-75W, INDUSTRIAL	270	0	0	0	0	0	0	0	0	0	0
2 LAMP, F96-215W, LOUVERED	516	0	0	0	0	0	0	0	0	0	0
2 LAMP, F96-110W, LOUVERED	264	0	0	0	0	0	0	0	0	0	0
2 LAMP, F96-75W, LOUVERED	180	0	0	0	0	0	0	0	0	0	0
1 LAMP, F96-215W, LOUVERED	258	0	0	0	0	0	0	0	0	0	0
1 LAMP, F96-110W, LOUVERED	132	0	0	0	0	0	0	0	0	0	0
1 LAMP, F96-75W, INDUSTRIAL	90	0	0	0	0	0	0	0	0	0	0
2 LAMP, F40U, 2x2, LAY-IN	96	0	0	0	0	0	0	0	0	0	0
1 LAMP, 400W-MH, HID	480	0	0	0	12,960	0	0	0	0	0	0
1 LAMP, 400W-MVR, MERC.	480	0	4,320	8,640	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	2,000	0	0	0	0	0	0	0	0	0	0
1 LAMP, 500W-PS, SOCKET	500	0	0	0	0	0	0	0	0	0	0
1 LAMP, 250W-MVR, MERC.	300	0	0	0	0	0	0	0	0	0	0
1 LAMP, 300W-PS, SOCKET	300	0	0	0	0	0	0	0	0	0	0
1 LAMP, 200W-PS, SOCKET	200	0	0	0	800	0	0	0	0	0	0
1 LAMP, 150W-A21, SOCKET	150	5,250	0	0	0	0	0	0	0	0	1,500
1 LAMP, 100W-A21, SOCKET	100	3,300	0	0	600	0	700	0	0	0	700
1 LAMP, 60W-A19, SOCKET	60	480	0	0	0	0	120	600	60	60	0
1 LAMP, 40W, SOCKET	40	0	0	0	0	0	0	0	0	0	0
BUILDING TOTALS		14,382	33,280	19,392	33,596	21,408	16,276	13,694	17,532	13,884	8,104

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	TOTAL FIXTURE WATTS BUILDING NUMBER									
		5,859	5,863								
4 LAMP, F40, LAY-IN	192	5,760	0								
4 LAMP, F40, POLYWRAP	182	0	10,556								
4 LAMP, F40, LOUVERED	192	0	0								
4 LAMP, F40, INDUSTRIAL	192	0	0								
3 LAMP, F40, LOUVERED	144	0	0								
3 LAMP, F40, INDUSTRIAL	144	0	0								
2 LAMP, F40, LAY-IN	96	96	0								
2 LAMP, F40, POLYWRAP	96	384	0								
2 LAMP, F40, LOUVERED	96	0	0								
2 LAMP, F40, INDUSTRIAL	96	4,992	0								
1 LAMP, F40, POLYWRAP	48	0	672								
1 LAMP, F40, LOUVERED	48	0	0								
1 LAMP, F40, INDUSTRIAL	48	0	0								
4 LAMP, F96-75W, INDUSTRIAL	360	0	0								
3 LAMP, F96-75W, INDUSTRIAL	270	0	0								
2 LAMP, F96-215W, LOUVERED	516	0	0								
2 LAMP, F96-110W, LOUVERED	264	0	0								
2 LAMP, F96-75W, LOUVERED	180	0	0								
1 LAMP, F96-215W, LOUVERED	258	0	0								
1 LAMP, F96-110W, LOUVERED	132	0	0								
1 LAMP, F96-75W, INDUSTRIAL	90	0	0								
2 LAMP, F40U, 2x2, LAY-IN	96	0	0								
1 LAMP, 400W-MH, HID	480	0	0								
1 LAMP, 400W-MVR, MERC.	480	0	0								
2 LAMP, 1000W, QUARTZ	2,000	0	0								
1 LAMP, 500W-PS, SOCKET	500	0	0								
1 LAMP, 250W-MVR, MERC.	300	0	0								
1 LAMP, 300W-PS, SOCKET	300	0	0								
1 LAMP, 200W-PS, SOCKET	200	0	0								
1 LAMP, 150W-A21, SOCKET	150	150	0								
1 LAMP, 100W-A21, SOCKET	100	0	100								
1 LAMP, 60W-A19, SOCKET	60	0	180								
1 LAMP, 40W, SOCKET	40	0	0								
BUILDING TOTALS		11,382	11,508								

UNIQUE BLDG. NO.	LIGHTING DEMAND WATTS	LIGHTING PERIOD HRS/YR	ANNUAL LIGHTING KWH	NO. OF SIMILAR BLDGS.	TOTAL ANNUAL KWH
1	40,450	2,080	84,136	0	84,136
8	10,700	2,080	22,256	0	22,256
11	15,094	2,080	31,396	5	188,376
12	15,890	2,080	33,051	2	99,153
13	46,700	2,080	97,136	0	97,136
51	26,956	2,080	56,068	0	56,068
54	11,048	2,080	22,980	0	22,980
55	15,984	2,080	33,247	0	33,247
56	43,184	2,080	89,823	0	89,823
58	32,486	2,080	67,571	0	67,571
111	43,194	2,080	89,844	0	89,844
311	8,040	2,080	16,723	0	16,723
500	107,386	2,080	223,363	2	670,089
512	67,338	2,080	140,063	2	420,189
720	17,412	2,080	36,217	1	72,434
722	23,148	2,080	48,148	0	48,148
723	35,876	2,080	74,622	1	149,244
724	21,280	2,080	44,262	0	44,262
725	35,128	2,080	73,066	0	73,066
762	28,324	2,080	58,914	3	235,656
769	26,892	2,080	55,935	1	111,870
738	28,508	2,080	59,297	1	118,594
746	29,084	2,080	60,495	0	60,495
754	21,220	2,080	44,138	0	44,138
1101	10,788	1,040	11,220	9	112,200
1102	6,580	1,040	6,843	4	34,215
1105	13,760	1,040	14,310	1	28,620
1106	10,794	1,040	11,226	1	22,452
1178	5,200	1,040	5,408	3	21,632
1270	9,532	2,080	19,827	4	99,135
1271	3,960	2,080	8,237	4	41,185
2322	24,596	1,040	25,580	3	102,320
2320	9,170	1,040	9,537	16	162,129
2333	9,632	1,040	10,017	7	80,136
2354	9,466	1,040	9,845	1	19,690
2527	83,848	2,080	174,404	0	174,404
2528	16,668	2,080	34,669	0	34,669
2529	29,912	2,080	62,217	0	62,217
2536	11,860	2,080	24,669	2	74,007
2588	147,096	2,080	305,960	0	305,960
5000	14,382	2,080	29,915	0	29,915
5804	33,280	2,080	69,222	0	69,222
5805	19,392	2,080	40,335	0	40,335
5808	33,596	2,080	69,880	0	69,880
5838	21,408	2,080	44,529	3	178,116
5849	16,276	2,080	33,854	2	101,562
5852	13,694	2,080	28,484	0	28,484
5854	17,532	2,080	36,467	0	36,467
5855	13,884	2,080	28,879	1	57,758
5858	8,104	2,080	16,856	0	16,856
5859	11,382	2,080	23,675	0	23,675
5863	11,508	2,080	23,937	1	47,874
TOTAL ANNUAL LIGHTING ENERGY					4,990,613

APPENDIX C

RECOMMENDED ECO CALCULATIONS

APPENDIX C
RECOMMENDED ECO CALCULATIONS

TABLE OF CONTENTS

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO: 1
DATE: 4/12/95
ECO TITLE: Replace Existing Incandescent And Mercury Vapor Lighting
INSTALLATION: Fort Bliss
LOCATION: El Paso, Texas

A. Summary:

Electrical Energy Savings	913,758	KWH/yr
Electrical Demand Savings	6,412	KW-mo/yr
Natural Gas Energy Penalty	537.5	MMBTU/yr
Net Energy Savings	2,581	MMBTU/yr
Annual Cost Savings	274,583	$/yr
Total Investment	640,824	$
Simple Payback	2.3	yrs
SIR	6.38	

B. ECO Description:

Remove 3,055 existing incandescent and mercury vapor light fixtures, and replace them with 2,463 new fluorescent and high pressure sodium light fixtures. The fluorescent fixtures should be specified with electronic ballasts and T8 lamps. Locate the new light fixtures over desks or other work tables as required to provide the Illumination Engineers Society's (IES) recommended design light levels at the work station in each room. This project shall require a new lighting layout design, demolition and removal of existing fixtures, and installation of new fixtures and associated wiring. All switching and circuitry is to remain the same wherever possible.

C. Discussion:

The facility currently has numerous incandescent and mercury vapor lighting systems in it's buildings. These existing light sources are inefficient and should be replaced with more efficient light sources, such as fluorescent and high pressure sodium. Figure C-1 shows the various existing light sources identified during the building walk through, and the suggested replacement source for each. All the new light fixtures which use these replacement light sources should be selected by the lighting designer. Refer to the building maps and data sheets in Appendix G for the existing light fixture quantities and locations.

D. Savings Calculations:

The energy savings calculations were based on the existing annual lighting energy consumption calculations, provided in Appendix B. In the savings calculations that follow, the existing annual energy consumptions of the incandescent and mercury vapor light fixtures were adjusted to account for the new quantity of fixtures in some rooms, and the higher efficiency of all the new fixtures to be installed.

Fixture Upgrade Factors (f_u): Using manufacturer's lamp input wattage data for the existing mercury and incandescent light fixtures, as well as for the suggested replacement light fixtures, the fixture upgrade factors were calculated in Figure C-1 using the following equation:

$$f_u = \frac{(input\ watts)_{NEW}}{(input\ watts)_{OLD}}$$

Fixture Quantity Factors (f_q): Using manufacturer's lamp lumen output data for the existing mercury and incandescent light fixtures, as well as for the suggested replacement light fixtures, the fixture quantity factors were calculated in Figure C-1 using the following equation:

$$f_q = \frac{(initial\ lumens)_{OLD}}{(inititial\ lumens)_{NEW}}$$

Figure C-1. Light Fixture Upgrade and Quantity Factors

EXIST FIXTURE LIGHT SOURCE	EXIST. LAMP LIFE HRS	EXIST LAMP INITIAL LUMENS	EXIST INPUT WATTS	SUGGESTED NEW FIXTURE LIGHT SOURCE	NEW LAMP LIFE HRS	NEW LAMP INITIAL LUMENS	NEW INPUT WATTS	FIXTURE UPGRADE FACTOR	FIXTURE QUANTITY FACTOR
40W INC	1,000	430	40	18W FLUOR	20,000	1,250	22	0.55	0.34
60W INC	1,000	1,060	60	18W FLUOR	20,000	1,250	22	0.37	0.85
100W INC	750	1,740	100	26W FLUOR	20,000	2,125	30	0.30	0.82
150W INC	1,000	2,650	150	32W FLUOR	20,000	2,850	31	0.21	0.93
200W INC	750	3,703	200	(2) 32W FLUOR	20,000	5,700	62	0.31	0.65
300W INC	750	6,103	300	(3) 32W FLUOR	20,000	8,550	88	0.29	0.71
500W INC.	1,000	10,850	500	(4) 32W FLUOR	20,000	11,400	124	0.25	0.95
250W MERC	24,000	12,000	300	150W HPS	24,000	16,000	180	0.60	0.75
400W MERC	24,000	21,000	480	200W HPS	24,000	22,000	240	0.50	0.95
1000W QUARTZ	2,000	21,500	1,000	400W HPS	24,000	50,000	480	0.48	0.43

Sample Calculation: 60W incandescent lamp/fixture, retrofit to 18W fluorescent lamp/fixture

From Figure C-1:

new input watts = 22
new lamp lumens = 1,250
old input watts = 60
old lamp lumens = 1,060

$$f_u = \frac{(22\ W)}{(60\ W)} = 0.37$$

$$f_q = \frac{(1{,}060\ lumens)}{(1{,}250\ lumens)} = 0.85$$

With the above factors determined, the number of new light fixtures to be installed and the energy savings for each building were calculated on the spreadsheets on pages C-9 through C-14. The following sample calculation demonstrates the procedure followed for each building.

Sample Calculation for Building #11, 1 lamp, 150W incandescent fixtures:

Exist. fixture quantity = 10 (from data sheets in Appendix G)

Fixture upgrade factor = 0.21 (from Figure C-1)

Fixture Quantity Factor = 0.93 (from Figure C-1)

(a) New fixture quantity (Q_N) for 150W fixtures only: (see page C-9)

$$Q_N = Q_E \, x \, f_q$$

where,

Q_E = existing quantity of fixtures in room
Q_N = new quantity of fixtures in room

$$Q_N = 10 \, x \, 0.93 = 10 \; fixtures$$

(b) Fixture Watt Savings (ΔW_f) for 150W fixtures only: (see page C-11)

$$\Delta W_f = W_O \, x \left[1 - \frac{Q_N}{Q_E} \, x \, f_u \right] \quad watts$$

where,

W_O = exist. total fixture wattage[1] = 1,500 KWH/yr

$$\Delta W_f = 1{,}500 \, x \left[1 - \frac{10}{10} \, x \, 0.21 \right] = 1{,}185 \; watts$$

(c) Total Fixture Watt Savings for All Old Fixtures in Building #11: (see page C-11)

$$\Delta W_f = 1{,}881 \; watts$$

(d) Lighting Savings (ΔE_L) for Building #11 only: (see page C-13)

$$\Delta E_L = \Delta W_f \, x \, H \, x \left[\frac{1 \; KW}{1{,}000 \; W} \right] \quad \frac{KWH}{yr}$$

where,

H = annual lighting period[2] = 2,080 hrs/yr

$$\Delta E_L = \left[1{,}881 \, x \, 2{,}080 \, x \, \frac{1}{1{,}000} \right] = 3{,}912 \; \frac{KWH}{yr}$$

(e) Total Lighting Savings (ΔE_L) for Building #11 and 5 Duplicate Buildings: (see page C-13)

$$\Delta E_L = 3{,}912 \; x \; [1 + 5 \; duplicates] = 23{,}472 \; \frac{KWH}{yr}$$

(f) Total Demand Savings (ΔD) for Building #11 and 5 Duplicate Buildings: (see page C-13)

$$\Delta D = \frac{23{,}472 \; KWH}{yr} \; x \; \frac{yr}{2{,}080 \; hrs} \; x \; \frac{12 \; Mo}{yr} = 135 \; \frac{KW\text{-}Mo}{yr}$$

(g) Total Cooling Energy Savings (ΔE_C) for Building #11 and 5 Duplicate Buildings: (see page C-13)

$$\Delta E_C = \frac{\Delta E_L \left(\frac{3413 \; BTU}{KWH} \right) H_C}{\left(EER \; x \; \frac{1{,}000 \; watts}{KW} \right)} \qquad \frac{KWH}{yr}$$

where,

EER[3] = cooling system efficiency = 30 BTU/W-hr
H_C[4] = percentage of year in cooling operation = 0.68

$$\Delta E_C = \frac{23{,}472 \; (3{,}413) \; 0.68}{(30 \; x \; 1{,}000)} = 1{,}816 \; \frac{KWH}{yr}$$

(h) Heating Energy Penalty (ΔE_H) for Building #11 and 5 Duplicate Buildings: (see page C-13)

$$\Delta E_H = \frac{\Delta E_L \left(\frac{3413 \; BTU}{KWH} \right) H_H}{EFF_H} \; x \; \frac{1 \; MMBTU}{1{,}000{,}000 \; BTU} \qquad \frac{MMBTU}{yr}$$

where,

EFF[5] = heating system efficiency = 0.70
H_H[6] = percentage of year in heating operation = 0.13

$$\Delta E_H = \frac{23{,}472 \; (3413) \; 0.13}{(0.70 \; x \; 1{,}000{,}000)} = 14.9 \; \frac{MMBTU}{yr}$$

The results of the building by building calculations are summarized on page C-13. Using these figures, the total electrical energy savings (ΔE_E) are as follows:

$$\Delta E_E = \left[(848{,}146 + 65{,}612)\ \frac{KWH}{yr}\ x\ \frac{3{,}413\ BTU}{KWH}\ x\ \frac{1\ MMBTU}{1{,}000{,}000\ BTU}\right] = 3{,}118.6\ \frac{MMBTU}{yr}$$

The electrical peak demand cost savings (ΔC_D) are as follows:

$$\Delta C_D = \Delta D_L\ x\ C_D$$

where,

C_D = avoided cost of demand[7] = \$21.50/KW
ΔD_L= total peak electrical demand savings = 6,412 KW-mo/yr (see page C-13)

$$\therefore \quad \Delta C_D = (6{,}412\ x\ 21.50) = \frac{\$137{,}858}{yr}$$

Because the total number of lamps have been reduced by this ECO, the facility will require less lighting maintenance. The Maintenance Cost Savings (ΔC_M) from this ECO are calculated as follows:

$$\Delta C_M = C_L\ x\ H\ x \left[\frac{Q_O}{L_O} - \frac{Q_N}{L_N}\right] \quad \frac{\$}{yr}$$

where,

C_L = relamping labor cost per lamp[8] = \$20/lamp
H = average annual lighting hours[9] = 2,080 hrs/yr
L_N = average rated new lamp life[10] = 20,000 hrs
L_O = average rated old lamp life[11] = 1,000 hrs
Q_N = quantity of new lamps = 4,466 (from page C-14)
Q_O = quantity of old lamps = 3,055 (from page C-14)

Using the total quantities of lamps, calculated on page C-14, the maintenance cost savings were estimated as follows:

$$\Delta C_M = (20)\ x\ (2{,}080)\ x \left[\frac{3{,}055}{1{,}000} - \frac{4{,}466}{20{,}000}\right] = 117{,}798\ \frac{\$}{yr}$$

E. Cost Estimate

The total construction and design costs for this ECO were estimated as on page C-7.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the program Life Cycle Cost In Design (LCCID), and data from the above calculations. From this analysis were determined the Total Annual Cost Savings, the Savings to Investment Ratio (SIR), and the Simple Payback Period. The summary sheet for the life cycle cost analysis is shown on page C-8. The results of the analysis are listed in the project summary on page C-1.

REFERENCES

1. From Appendix B calculations of existing annual energy consumption for this type of fixture and building #11.
2. Per Appendix B calculations for annual lighting periods.
3. Reference Appendix B for cooling system efficiency calculation.
4. Reference Appendix B for cooling period calculation.
5. Reference Appendix B for heating system efficiency calculation.
6. Reference Appendix B for heating period calculation.
7. See Appendix A for calculation of demand costs.
8. Reference maintenance supervisor, 1 hr per lamp at labor rate of $20 per hour.
9. Reference Appendix B, annual lighting period calculations.
10. Per Illumination Engineers Society (IES) lamp data.
11. Per IES lamp data.

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Fort Bliss, Texas

PROJECT NO: 03-0185.01 **DATE:** 5/10/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: ECO-1, Replace Existing Incandescent And Mercury Vapor Lighting

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Demolition of existing incandescent light fixtures	3,016	ea	1.0	10.00	30,160			30,160
Demolition of existing mercury vapor light fixtures	39	ea	1.0	15.00	585			585
Miscellaneous cutting and patching of ceilings	3,055	ea	1.0	5.00	15,275	5.00	15,275	30,550
Miscellaneous wire, conduit and electrical parts	2,378	ea	1.0	5.00	11,890	5.00	11,890	23,780
Installation of new 18W fluorescent light fixtures	12	ea	1.0	30.00	360	60.00	720	1,080
Installation of new 26W fluorescent light fixtures	357	ea	1.0	30.00	10,710	70.00	24,990	35,700
Installation of new 32W fluorescent light fixtures	12	ea	1.0	30.00	360	80.00	960	1,320
Installation of new 2 lamp, 32W fluorescent light fixtures	458	ea	1.0	30.00	13,740	80.00	36,640	50,380
Installation of new 3 lamp, 32W fluorescent light fixtures	313	ea	1.0	30.00	9,390	100.00	31,300	40,690
Installation of new 4 lamp, 32W fluorescent light fixtures	335	ea	1.0	30.00	10,050	100.00	33,500	43,550
Installation of new 150W, HPS lowbay fixtures	478	ea	1.0	45.00	21,510	200.00	95,600	117,110
Installation of new 200W, HPS lowbay fixtures	382	ea	1.0	45.00	17,190	250.00	95,500	112,690
Installation of new 400W, HPS lowbay fixtures	31	ea	1.0	45.00	1,395	300.00	9,300	10,695
SUBTOTAL					142,615		355,675	498,290
O & P @ 20%					28,523		71,135	74,744
SUBTOTAL					171,138		426,810	573,034
DESIGN @ 6%								34,382
SUBTOTAL								607,416
SIOH @ 5.5%								33,408
TOTAL								$640,824

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LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: BLISS
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT BLISS REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-03 EEAP LIGHTING STUDY SURVEY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-1
ANALYSIS DATE: 05-09-95 ECONOMIC LIFE 20 YEARS PREPARED BY: PIEPER

1. INVESTMENT

A. CONSTRUCTION COST	$ 573034.	
B. SIOH	$ 33408.	
C. DESIGN COST	$ 34382.	
D. TOTAL COST (1A+1B+1C)	$ 640824.	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0.	
F. PUBLIC UTILITY COMPANY REBATE	$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)		$ 640824.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.46	3119.	$ 20146.	15.08	$ 303804.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.27	-538.	$ -1219.	18.58	$ -22650.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 137858.	14.88	$ 2051327.
N. TOTAL		2581.	$ 156785.		$ 2332481.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 117798.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 1752834.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)	$ 1752834.
4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))	$ 274583.
5. SIMPLE PAYBACK PERIOD (1G/4)	2.33 YEARS
6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C)	$ 4085316.
7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= (IF < 1 PROJECT DOES NOT QUALIFY)	6.38
8. ADJUSTED INTERNAL RATE OF RETURN (AIRR):	13.00 %

LIGHT FIXTURE TYPE	FIXTURE QUANTITY FACTOR	NEW FIXTURE QUANTITY BUILDING NUMBER									
		1	8	11	12	13	51	54	55	56	58
1 LAMP, 400W-MVR, MERC.	0.34	0	0	0	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	0.85	0	0	0	0	0	0	0	0	0	0
1 LAMP, 500W-PS, SOCKET	0.82	0	0	0	0	0	24	0	6	4	0
1 LAMP, 250W-MVR, MERC.	0.93	0	0	0	0	0	0	0	0	0	0
1 LAMP, 300W-PS, SOCKET	0.65	0	0	0	0	0	1	0	0	0	0
1 LAMP, 200W-PS, SOCKET	0.71	0	0	0	1	0	0	2	0	0	18
1 LAMP, 150W-A21, SOCKET	0.95	0	0	10	14	0	4	6	6	2	0
1 LAMP, 100W-A19, SOCKET	0.75	6	2	6	10	14	0	0	2	12	2
1 LAMP, 60W-A19, SOCKET	0.95	16	14	2	10	0	2	0	0	15	28
1 LAMP, 40W, SOCKET	0.43	0	0	0	0	5	0	1	0	0	0
TOTALS:		22	16	18	35	19	31	9	14	33	48

LIGHT FIXTURE TYPE	FIXTURE QUANTITY FACTOR	NEW FIXTURE QUANTITY BUILDING NUMBER									
		111	311	500	512	720	722	723	724	725	762
1 LAMP, 400W-MVR, MERC.	0.34	0	0	0	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	0.85	0	0	0	0	0	0	0	0	0	0
1 LAMP, 500W-PS, SOCKET	0.82	0	0	0	0	0	24	0	6	4	0
1 LAMP, 250W-MVR, MERC.	0.93	0	0	0	0	0	0	0	0	0	0
1 LAMP, 300W-PS, SOCKET	0.65	0	0	0	0	0	1	0	0	0	0
1 LAMP, 200W-PS, SOCKET	0.71	1	0	4	1	3	0	0	0	0	1
1 LAMP, 150W-A21, SOCKET	0.95	0	0	10	14	0	4	6	6	2	0
1 LAMP, 100W-A21, SOCKET	0.75	9	22	2	37	1	2	6	6	32	0
1 LAMP, 60W-A19, SOCKET	0.95	12	7	23	12	0	0	0	0	0	0
1 LAMP, 40W, SOCKET	0.43	0	9	0	3	0	0	0	0	0	0
TOTALS:		22	38	39	67	4	31	12	18	38	1

LIGHT FIXTURE TYPE	FIXTURE QUANTITY FACTOR	NEW FIXTURE QUANTITY BUILDING NUMBER									
		769	738	746	754	1,101	1,102	1,105	1,106	1,178	1,270
1 LAMP, 400W-MVR, MERC.	0.34	0	0	0	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	0.85	0	0	0	0	0	0	0	0	0	0
1 LAMP, 500W-PS, SOCKET	0.82	0	0	0	24	0	0	0	3	0	0
1 LAMP, 250W-MVR, MERC.	0.93	0	0	0	0	0	0	0	6	0	0
1 LAMP, 300W-PS, SOCKET	0.65	0	0	0	0	0	0	0	0	0	0
1 LAMP, 200W-PS, SOCKET	0.71	0	0	0	0	11	0	7	9	18	0
1 LAMP, 150W-A21, SOCKET	0.95	0	6	6	2	1	0	0	0	0	1
1 LAMP, 100W-A21, SOCKET	0.75	0	6	6	2	2	1	0	0	0	1
1 LAMP, 60W-A19, SOCKET	0.95	24	0	0	0	2	0	4	0	0	0
1 LAMP, 40W, SOCKET	0.43	0	0	0	0	0	0	0	0	0	0
TOTALS:		24	12	12	28	16	1	11	18	18	2

LIGHT FIXTURE TYPE	FIXTURE QUANTITY FACTOR	NEW FIXTURE QUANTITY BUILDING NUMBER									
		1,271	2,322	2,320	2,333	2,354	2,527	2,528	2,529	2,536	2,588
1 LAMP, 400W-MVR, MERC.	0.34	0	0	0	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	0.85	0	0	0	0	0	0	0	3	0	0
1 LAMP, 500W-PS, SOCKET	0.82	0	24	0	0	0	0	12	0	17	100
1 LAMP, 250W-MVR, MERC.	0.93	0	0	0	0	0	0	0	0	0	0
1 LAMP, 300W-PS, SOCKET	0.65	0	21	18	1	0	14	18	0	0	26
1 LAMP, 200W-PS, SOCKET	0.71	0	0	0	0	0	0	0	33	1	11
1 LAMP, 150W-A21, SOCKET	0.95	0	0	0	0	1	0	0	4	0	34
1 LAMP, 100W-A21, SOCKET	0.75	0	1	1	4	1	1	0	3	0	11
1 LAMP, 60W-A19, SOCKET	0.95	0	0	1	0	0	11	0	0	0	3
1 LAMP, 40W, SOCKET	0.43	0	0	0	0	0	7	0	0	0	0
TOTALS:		0	46	20	5	2	33	30	43	18	185

LIGHT FIXTURE TYPE	FIXTURE QUANTITY FACTOR	NEW FIXTURE QUANTITY BUILDING NUMBER									
		5,000	5,804	5,805	5,808	5,838	5,849	5,852	5,854	5,855	5,858
1 LAMP, 400W-MVR, MERC.	0.34	0	3	6	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	0.85	0	0	0	0	0	0	0	0	0	0
1 LAMP, 500W-PS, SOCKET	0.82	0	0	0	0	0	0	0	0	0	0
1 LAMP, 250W-MVR, MERC.	0.93	0	0	0	0	0	0	0	0	0	0
1 LAMP, 300W-PS, SOCKET	0.65	0	0	0	0	0	0	0	0	0	0
1 LAMP, 200W-PS, SOCKET	0.71	0	0	0	3	0	0	0	0	0	0
1 LAMP, 150W-A21, SOCKET	0.95	33	0	0	0	0	0	0	0	0	10
1 LAMP, 100W-A21, SOCKET	0.75	25	0	0	5	0	5	0	0	0	5
1 LAMP, 60W-A19, SOCKET	0.95	8	0	0	0	0	2	10	1	1	0
1 LAMP, 40W, SOCKET	0.43	0	0	0	0	0	0	0	0	0	0
TOTALS:		66	3	6	8	0	7	10	1	1	15

LIGHT FIXTURE TYPE	FIXTURE QUANTITY FACTOR	NEW FIXTURE QUANTITY BUILDING NUMBER									
		5,859	5,863								
1 LAMP, 400W-MVR, MERC.	0.34	0	0	0	0	0	0	0	0	0	0
2 LAMP, 1000W, QUARTZ	0.85	0	0	0	0	0	0	0	0	0	0
1 LAMP, 500W-PS, SOCKET	0.82	0	0	0	0	0	0	0	0	0	0
1 LAMP, 250W-MVR, MERC.	0.93	0	0	0	0	0	0	0	0	0	0
1 LAMP, 300W-PS, SOCKET	0.65	0	0	0	0	0	0	0	0	0	0
1 LAMP, 200W-PS, SOCKET	0.71	0	0	0	0	0	0	0	0	0	0
1 LAMP, 150W-A21, SOCKET	0.95	1	0	0	0	0	0	0	0	0	0
1 LAMP, 100W-A21, SOCKET	0.75	0	1	0	0	0	0	0	0	0	0
1 LAMP, 60W-A19, SOCKET	0.95	0	3	0	0	0	0	0	0	0	0
1 LAMP, 40W, SOCKET	0.43	0	0	0	0	0	0	0	0	0	0
TOTALS:		1	4								

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			1	8	11	12	13	51	54	55	56	58
1 LAMP, 400W-MVR, MERC.	480	0.50										
2 LAMP, 1000W, QUARTZ	2,000	0.48										
1 LAMP, 500W-PS, SOCKET	500	0.25						11,500		2,750	2,000	
1 LAMP, 250W-MVR, MERC.	300	0.60										
1 LAMP, 300W-PS, SOCKET	300	0.29						513				
1 LAMP, 200W-PS, SOCKET	200	0.31				338			476			3,884
1 LAMP, 150W-A21, SOCKET	150	0.21			1,185	1,809		474	711	711	237	
1 LAMP, 100W-A19, SOCKET	100	0.30	620	140	620	1,000	1,380			140	1,240	240
1 LAMP, 60W-A19, SOCKET	60	0.37	665	589	76	438		76			627	1,118
1 LAMP, 40W, SOCKET	40	0.55					370		98			
BUILDING TOTALS			1,285	729	1,881	3,585	1,750	12,563	1,285	3,601	4,104	5,242

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			111	311	500	512	720	722	723	724	725	762
1 LAMP, 400W-MVR, MERC.	480	0.50										
2 LAMP, 1000W, QUARTZ	2,000	0.48										
1 LAMP, 500W-PS, SOCKET	500	0.25						11,500		2,750	2,000	
1 LAMP, 250W-MVR, MERC.	300	0.60										
1 LAMP, 300W-PS, SOCKET	300	0.29						513				
1 LAMP, 200W-PS, SOCKET	200	0.31	338		752	138	614					338
1 LAMP, 150W-A21, SOCKET	150	0.21			1,185	1,809		474	711	711	237	
1 LAMP, 100W-A21, SOCKET	100	0.30	930	2,240	240	3,790	70	140	620	620	3,240	
1 LAMP, 60W-A19, SOCKET	60	0.37	514	265	929	514						
1 LAMP, 40W, SOCKET	40	0.55		682	40	254						
BUILDING TOTALS			1,782	3,187	3,146	6,505	684	12,627	1,331	4,081	5,477	338

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			769	738	746	754	1101	1102	1105	1106	1178	1270
1 LAMP, 400W-MVR, MERC.	480	0.50										
2 LAMP, 1000W, QUARTZ	2,000	0.48										
1 LAMP, 500W-PS, SOCKET	500	0.25				11,500				1,625		
1 LAMP, 250W-MVR, MERC.	300	0.60								720		
1 LAMP, 300W-PS, SOCKET	300	0.29										
1 LAMP, 200W-PS, SOCKET	200	0.31					2,518		1,566	1,842	4,084	
1 LAMP, 150W-A21, SOCKET	150	0.21		711	711	237	119					119
1 LAMP, 100W-A21, SOCKET	100	0.30		620	620	140	140	70				70
1 LAMP, 60W-A19, SOCKET	60	0.37	967				76		151			
1 LAMP, 40W, SOCKET	40	0.55										
BUILDING TOTALS			967	1,331	1,331	11,877	2,853	70	1,717	4,187	4,084	189

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			1271	2322	2320	2338	2354	2527	2528	2529	2536	2588
1 LAMP, 400W-MVR, MERC.	480	0.50										
2 LAMP, 1000W, QUARTZ	2,000	0.48								5,120		
1 LAMP, 500W-PS, SOCKET	500	0.25		11,500					6,000		8,375	48,500
1 LAMP, 250W-MVR, MERC.	300	0.60										
1 LAMP, 300W-PS, SOCKET	300	0.29		8,073	6,534	218		5,082	6,834			9,738
1 LAMP, 200W-PS, SOCKET	200	0.31								7,154	338	2,518
1 LAMP, 150W-A21, SOCKET	150	0.21					119			474		4,329
1 LAMP, 100W-A21, SOCKET	100	0.30		70	70	380	70	70		310		1,170
1 LAMP, 60W-A19, SOCKET	60	0.37			38			476				118
1 LAMP, 40W, SOCKET	40	0.55						526				
BUILDING TOTALS			0	19,643	6,642	598	189	6,154	12,834	13,058	8,713	66,368

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			5000	5804	5805	5808	5838	5849	5852	5854	5855	5858
1 LAMP, 400W-MVR, MERC.	480	0.50		3,600	7,200							
2 LAMP, 1000W, QUARTZ	2,000	0.48										
1 LAMP, 500W-PS, SOCKET	500	0.25										
1 LAMP, 250W-MVR, MERC.	300	0.60										
1 LAMP, 300W-PS, SOCKET	300	0.29										
1 LAMP, 200W-PS, SOCKET	200	0.31				614						
1 LAMP, 150W-A21, SOCKET	150	0.21	4,211									1,186
1 LAMP, 100W-A21, SOCKET	100	0.30	2,550			450		550				550
1 LAMP, 60W-A19, SOCKET	60	0.37	302					76	378	38	38	
1 LAMP, 40W, SOCKET	40	0.55										
BUILDING TOTALS			7,063	3,600	7,200	1,064	0	626	378	38	38	1,735

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			5859	5863								
1 LAMP, 400W-MVR, MERC.	480	0.50										
2 LAMP, 1000W, QUARTZ	2,000	0.48										
1 LAMP, 500W-PS, SOCKET	500	0.25										
1 LAMP, 250W-MVR, MERC.	300	0.60										
1 LAMP, 300W-PS, SOCKET	300	0.29										
1 LAMP, 200W-PS, SOCKET	200	0.31										
1 LAMP, 150W-A21, SOCKET	150	0.21	119									
1 LAMP, 100W-A21, SOCKET	100	0.30		70								
1 LAMP, 60W-A19, SOCKET	60	0.37		113								
1 LAMP, 40W, SOCKET	40	0.55										
BUILDING TOTALS			119	183								

UNIQUE BLDG. NO.	TOTAL FIXTURE WATT SAVINGS	LIGHTING PERIOD HRS/YR	LIGHTING SAVINGS KWH/YR	NO. OF SIMILAR BLDGS.	TOTAL LIGHTING SAVINGS KWH/YR	TOTAL DEMAND SAVINGS KW-MO/YR	TOTAL COOLING SAVINGS KWH/YR	TOTAL HEATING PENALTY MMBTU/YR
1	1,285	2,080	2,673	0	2,673	15	207	1.7
8	729	2,080	1,516	0	1,516	9	117	1.0
11	1,881	2,080	3,912	5	23,472	135	1,816	14.9
12	3,585	2,080	7,457	2	22,371	129	1,731	14.2
13	1,750	2,080	3,640	0	3,640	21	282	2.3
51	12,563	2,080	26,131	0	26,131	151	2,022	16.6
54	1,285	2,080	2,673	0	2,673	15	207	1.7
55	3,601	2,080	7,490	0	7,490	43	579	4.7
56	4,104	2,080	8,536	0	8,536	49	660	5.4
58	5,242	2,080	10,903	0	10,903	63	843	6.9
111	1,782	2,080	3,707	0	3,707	21	287	2.3
311	3,187	2,080	6,629	0	6,629	38	513	4.2
500	3,146	2,080	6,544	2	19,632	113	1,519	12.4
512	6,505	2,080	13,530	2	40,590	234	3,140	25.7
720	684	2,080	1,423	1	2,846	16	220	1.8
722	12,627	2,080	26,264	0	26,264	152	2,032	16.6
723	1,331	2,080	2,768	1	5,536	32	428	3.5
724	4,081	2,080	8,488	0	8,488	49	657	5.4
725	5,477	2,080	11,392	0	11,392	66	881	7.2
762	338	2,080	703	3	2,812	16	218	1.8
769	967	2,080	2,011	1	4,022	23	311	2.5
738	1,331	2,080	2,768	1	5,536	32	428	3.5
746	1,331	2,080	2,768	0	2,768	16	214	1.8
754	11,877	2,080	24,704	0	24,704	143	1,911	15.7
1101	2,853	1,040	2,967	9	29,670	342	2,295	18.8
1102	70	1,040	73	4	365	4	28	0.2
1105	1,717	1,040	1,786	1	3,572	41	276	2.3
1106	4,187	1,040	4,354	1	8,708	100	674	5.5
1178	4,084	1,040	4,247	3	16,988	196	1,314	10.8
1270	189	2,080	393	4	1,965	11	152	1.2
1271	0	2,080	0	4	0	0	0	0.0
2322	19,643	1,040	20,429	3	81,716	943	6,322	51.8
2320	6,642	1,040	6,908	16	117,436	1,355	9,085	74.4
2333	593	1,040	617	7	4,936	57	382	3.1
2354	189	1,040	197	1	394	5	30	0.2
2527	6,154	2,080	12,800	0	12,800	74	990	8.1
2528	12,834	2,080	26,695	0	26,695	154	2,065	16.9
2529	13,058	2,080	27,161	0	27,161	157	2,101	17.2
2536	8,713	2,080	18,123	2	54,369	314	4,206	34.5
2588	66,368	2,080	138,045	0	138,045	796	10,679	87.5
5000	7,063	2,080	14,691	0	14,691	85	1,137	9.3
5804	3,600	2,080	7,488	0	7,488	43	579	4.7
5805	7,200	2,080	14,976	0	14,976	86	1,159	9.5
5808	1,064	2,080	2,213	0	2,213	13	171	1.4
5838	0	2,080	0	3	0	0	0	0.0
5849	626	2,080	1,302	2	3,906	23	302	2.5
5852	378	2,080	786	0	786	5	61	0.5
5854	38	2,080	79	0	79	0	6	0.1
5855	38	2,080	79	2	237	1	18	0.2
5858	1,735	2,080	3,609	0	3,609	21	279	2.3
5859	119	2,080	248	0	248	1	19	0.2
5863	183	2,080	381	1	762	4	59	0.5
TOTALS:					848,146	6,412	65,612	537.5

UNIQUE BLDG. NO.	OLD FIXTURE QTY	OLD LAMP QTY	NEW FIXTURE QTY	NEW LAMP QTY	NO. OF SIMILAR BLDGS.	TOTAL OLD FIXTURE QTY	TOTAL NEW FIXTURE QTY	TOTAL OLD LAMP QTY	TOTAL NEW LAMP QTY
1	25	25	22	22	0	25	22	25	22
8	17	17	16	16	0	17	16	17	16
11	20	20	18	48	5	120	108	120	288
12	41	41	35	79	2	123	105	123	237
13	30	30	19	19	0	30	19	30	19
51	37	37	31	44	0	37	31	37	44
54	12	12	9	31	0	12	9	12	31
55	15	15	14	32	0	15	14	15	32
56	39	39	33	39	0	39	33	39	39
58	57	57	48	84	0	57	48	57	84
111	27	27	22	24	0	27	22	27	24
311	58	58	38	38	0	58	38	58	38
500	43	43	39	77	2	129	117	129	231
512	86	86	67	111	2	258	201	258	333
720	5	5	4	10	1	10	8	10	20
722	37	37	31	44	0	37	31	37	44
723	14	14	12	30	1	28	24	28	60
724	21	21	18	36	0	21	18	21	36
725	49	49	38	44	0	49	38	49	44
762	2	2	1	3	3	8	4	8	12
769	25	25	24	24	1	50	48	50	48
738	14	14	12	30	1	28	24	28	60
746	14	14	12	30	0	14	12	14	30
754	33	33	28	34	0	33	28	33	34
1101	21	21	16	41	9	210	160	210	410
1102	1	1	1	1	4	5	5	5	5
1105	14	14	11	25	1	28	22	28	50
1106	22	22	18	36	1	44	36	44	72
1178	26	26	18	54	3	104	72	104	216
1270	2	2	2	5	4	10	10	10	25
1271	0	0	0	0	4	0	0	0	0
2322	63	63	46	67	3	252	184	252	268
2320	29	29	20	38	16	493	340	493	646
2333	6	6	5	6	7	48	40	48	48
2354	2	2	2	5	1	4	4	4	10
2527	51	51	33	47	0	51	33	51	47
2528	43	43	30	48	0	43	30	43	48
2529	58	58	43	121	0	58	43	58	121
2536	23	23	18	20	2	69	54	69	60
2588	232	232	185	335	0	232	185	232	335
5000	76	76	66	165	0	76	66	76	165
5804	9	9	3	3	0	9	3	9	3
5805	18	18	6	6	0	18	6	18	6
5808	10	10	8	14	0	10	8	10	14
5838	0	0	0	0	3	0	0	0	0
5849	9	9	7	7	2	27	21	27	21
5852	10	10	10	10	0	10	10	10	10
5854	1	1	1	1	0	1	1	1	1
5855	1	1	1	1	1	2	2	2	2
5858	17	17	15	45	0	17	15	17	45
5859	1	1	1	4	0	1	1	1	4
5863	4	4	4	4	1	8	8	8	8
TOTAL:						3,055	2,377	3,055	4,466

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO: 2
DATE: 4/12/95
ECO TITLE: Replace Existing Fluorescent Lighting With Electronic Fluorescent Lighting
INSTALLATION: Fort Bliss
LOCATION: El Paso, Texas

A. Summary:

Electrical Energy Savings	1,614,040	KWH/yr
Electrical Demand Savings	9,191	KW-mo/yr
Natural Gas Energy Penalty	949.3	MMBTU/yr
Net Energy Savings	4,559	MMBTU/yr
Annual Cost Savings	231,039	$/yr
Total Investment	1,536,567	$
Simple Payback	6.6	yrs
SIR	2.24	

B. ECO Description:

Remove the existing magnetic ballasts and T12 lamps from 11,952 fluorescent light fixtures and replace them with new electronic ballasts and T8 lamps. In some cases it may be more cost effective to simply replace the entire light fixture. This project shall require an engineering specification for the new fluorescent ballasts and lamps, demolition and removal of existing equipment and installation of new equipment. All switching and circuitry is to remain the same.

C. Discussion:

The facility currently has much fluorescent lighting in it's buildings. These existing light fixtures typically have the T12 lamps and standard magnetic ballasts. The existing fixtures should be retrofitted with new electronic ballasts and T8 lamps. These newer electronic ballasts and lamps are more efficient and use less energy.

D. Savings Calculations:

The energy savings calculations were based on the existing annual lighting energy consumption calculations, provided in Appendix B. The existing annual energy consumptions of the fluorescent light fixtures were adjusted to account for the higher efficiency of the new fixtures with electronic ballasts and T8 lamps. These calculations were performed on both 4' and 8' fluorescent light fixtures.

Fixture Upgrade Factors (f): The fixture upgrade factors used in the savings calculations are listed in Figure C-2, and were calculated using fluorescent ballast manufacturer's data and the following equation:

$$f = \frac{(ballast\ input\ watts)_{NEW}}{(ballast\ input\ watts)_{OLD}}$$

Figure C-2. Fixture Upgrade Factors

EXIST FIXTURE LIGHT SOURCE	EXIST INPUT WATTS	SUGGESTED NEW FIXTURE LIGHT SOURCE	NEW INPUT WATTS	FIXTURE UPGRADE FACTOR
4, F40T12 LAMPS	192	4, F32T8 LAMPS	110	0.57
3, F40T12 LAMPS	144	3, F32T8 LAMPS	88	0.61
2, F40T12 LAMPS	96	2, F32T8 LAMPS	62	0.65
1, F40T12 LAMP	48	1, F32T8 LAMP	31	0.65
4, F96T12 75W LAMPS	360	4, F96T8 59W LAMPS	210	0.58
3, F96T12 75W LAMPS	270	3, F96T8 59W LAMPS	158	0.59
2, F9T12 75W LAMPS	180	2, F96T8 59W LAMPS	105	0.58
1, F96T12 75W LAMP	90	1, F96T8 59W LAMP	53	0.59

Sample Calculation:

4' fluorescent light fixtures
4, F40T12 lamps per fixture
old ballast input = 192W
new ballast input = 110W

$$f = \frac{(110\ W)}{(192\ W)} = 0.57$$

With the above factors determined, the energy savings for each building were calculated on the spreadsheets on pages C-22 through C-25. The following sample calculation demonstrates the procedure followed for each building, based on data from the ECO Data Sheets in Appendix G.

Sample Calculation for Building #1, 4 lamp, F40 Lay-in fixtures:
Exist. fixture quantity = 142 (from data sheets in Appendix G)
Fixture upgrade factor = 0.57 (from Figure C-2)

(a) Fixture Watt Savings ($\triangle W_f$) for 4 lamp, F40, lay-in fixtures only: (see page C-22)

$$\triangle W_f = W_O \times [\ 1 - f\ ] \quad watts$$

where,
W_O = exist. total fixture wattage[1] = 27,264 KWH/yr

$$\triangle W_f = 27{,}264 \times [\ 1 - 0.57\ ] = 11{,}724\ watts$$

(b) Total Fixture Watt Savings for All Old Fixtures in Building #1: (see page C-22)

$$\Delta W_f = 16{,}257 \text{ watts}$$

(c) Lighting Savings (ΔE_L) for Building #1 only: (see page C-25)

$$\Delta E_L = \Delta W_f \times H \times \left[\frac{1\ KW}{1{,}000\ W}\right] \quad \frac{KWH}{yr}$$

where,

H = annual lighting period[2] = 2,080 hrs/yr

$$\therefore \quad \Delta E_L = \left[16{,}257 \times 2{,}080 \times \frac{1}{1{,}000}\right] = 33{,}815 \ \frac{KWH}{yr}$$

(d) Total Lighting Savings (ΔE_L) for Building #1 and 0 Duplicate Buildings: (see page C-25)

$$\Delta E_L = 33{,}815 \times [1 + 0 \ duplicates] = 33{,}815 \ \frac{KWH}{yr}$$

(e) Total Demand Savings (ΔD) for Building #1 and 0 Duplicate Buildings: (see page C-25)

$$\Delta D = \frac{33{,}815\ KWH}{yr} \times \frac{yr}{2{,}080\ hrs} \times \frac{12\ Mo}{yr} = 195 \ \frac{KW\text{-}Mo}{yr}$$

(f) Total Cooling Energy Savings (ΔE_C) for Building #1 and 0 Duplicate Buildings: (see page C-25)

$$\Delta E_C = \frac{\Delta E_L \left(\frac{3413\ BTU}{KWH}\right) H_C}{\left(EER \times \frac{1{,}000\ watts}{KW}\right)} \quad \frac{KWH}{yr}$$

where,

EER[3] = cooling system efficiency = 30 BTU/W-hr

H_C[4] = percentage of year in cooling operation = 0.68

$$\Delta E_C = \frac{33{,}815\ (3{,}413)\ 0.68}{(30 \times 1{,}000)} = 2{,}616 \ \frac{KWH}{yr}$$

(g) Total Heating Energy Penalty (ΔE_H) for Building #1 and 0 Duplicate Buildings: (see page C-25)

$$\Delta E_H = \frac{\Delta E_L \left(\frac{3413\ BTU}{KWH}\right) H_H}{EFF_H} \times \frac{1\ MMBTU}{1{,}000{,}000\ BTU} \quad \frac{MMBTU}{yr}$$

where,

EFF[5] = heating system efficiency = 0.70
H_H[6] = percentage of year in heating operation = 0.13

$$\Delta E_H = \frac{33{,}815\ (3413)\ 0.13}{(0.70 \times 1{,}000{,}000)} = 21.4\ \frac{MMBTU}{yr}$$

The results of the building by building calculations are summarized on page C-25. Using these figures, the Total Electrical Energy Savings (ΔE_E) are as follows:

$$\Delta E_E = \left[(1{,}498{,}140 + 115{,}900)\ \frac{KWH}{yr} \times \frac{3{,}413\ BTU}{KWH} \times \frac{1\ MMBTU}{1{,}000{,}000\ BTU}\right] = 5{,}508.7\ \frac{MMBTU}{yr}$$

The Electrical Peak Demand Cost Savings (ΔC_D) are as follows:

$$\Delta C_D = \Delta D_L \times C_D$$

where,

C_D = avoided cost of demand[7] = $21.50/KW
ΔD_L= total peak electrical demand savings = 9,191 KW-mo/yr (see page C-25)

$$\Delta C_D = (9{,}191 \times 21.50) = \frac{\$197{,}606}{yr}$$

E. Cost Estimate

The total construction and design costs for this ECO were estimated on page C-20.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the program Life Cycle Cost In Design (LCCID), and data from the above calculations. From this analysis were determined the Total Annual Cost Savings, the Savings to Investment Ratio (SIR), and the Simple Payback Period. The summary sheet for the life cycle cost analysis is shown on page C-21. The results of the analysis are listed in the project summary on page C-15.

REFERENCES

1. From Appendix B calculations of existing annual energy consumption for this type of fixture and building #1.

2. Per Appendix B calculations for annual lighting periods.

3. Reference Appendix B for cooling system efficiency calculation.

4. Reference Appendix B for cooling period calculation.

5. Reference Appendix B for heating system efficiency calculation.

6. Reference Appendix B for heating period calculation.

7. See Appendix A for calculation of demand costs.

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: Fort Bliss, Texas

PROJECT NO: 03-0185.01 **DATE:** 3/17/95

BY : PIEPER, C.A. **CHECKED BY:** X

PROJECT DESCRIPTION: ECO-2, Replace Existing Fluorescent Lighting With Electronic Fluorescent Lighting

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Installation of new lamp sockets in existing fluorescent fixtures	23,526	ea	1.0	5.00	117,630	8.00	188,208	305,838
Installation of new F32T8 electronic ballasts	22,495	ea	1.0	15.00	337,425	16.70	375,667	713,092
Installation of new F32T8 lamps and sockets	43,717	ea	1.0			2.65	115,850	115,850
Installation of new F96T8 electronic ballasts	1,031	ea	1.0	15.00	15,465	29.38	30,291	45,756
Installation of new F96T8 lamps and sockets	1,389	ea	1.0			10.27	14,265	14,265
SUBTOTAL					470,520		724,281	1,194,801
O & P @ 20%					94,104		144,856	179,220
SUBTOTAL					564,624		869,137	1,374,021
DESIGN @ 6%								82,441
SUBTOTAL								1,456,462
SIOH @ 5.5%								80,105
TOTAL								$1,536,567

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LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: BLISS
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT BLISS REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 03-0185-03 EEAP LIGHTING STUDY SURVEY
FISCAL YEAR 1995 DISCRETE PORTION NAME: ECO-2
ANALYSIS DATE: 05-09-95 ECONOMIC LIFE 20 YEARS PREPARED BY: PIEPER

1. INVESTMENT

A. CONSTRUCTION COST	$ 1374021.		
B. SIOH	$ 80105.		
C. DESIGN COST	$ 82441.		
D. TOTAL COST (1A+1B+1C)	$ 1536567.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 1536567.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 6.46	5509.	$ 35586.	15.08	$ 536640.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.27	-949.	$ -2153.	18.58	$ -40003.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 197606.	14.88	$ 2940377.
N. TOTAL		4559.	$ 231039.		$ 3437014.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 0.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 231039.

5. SIMPLE PAYBACK PERIOD (1G/4) 6.65 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 3437014.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.24
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 7.23 %

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			1	8	11	12	13	51	54	55	56	58
AMP, F40, LAY-IN	192	0.57	11,724	0	1,981	991	6,109	4,788	2,972	3,880	8,091	7,100
AMP, F40, POLYWRAP	192	0.57	2,064	0	1,569	1,734	826	0	83	330	0	0
AMP, F40, LOUVERED	192	0.57	0	2,724	0	0	4,376	0	0	0	1,238	0
AMP, F40, INDUSTRIAL	192	0.57	0	0	1,651	0	0	0	0	0	991	165
AMP, F40, LOUVERED	144	0.61	0	337	0	0	0	0	0	0	1,011	0
AMP, F40, INDUSTRIAL	144	0.61	0	0	0	0	0	0	0	0	0	0
AMP, F40, LAY-IN	96	0.65	336	0	0	0	571	0	0	0	0	0
AMP, F40, POLYWRAP	96	0.65	168	0	269	470	168	0	437	0	437	0
AMP, F40, LOUVERED	96	0.65	437	840	0	168	638	0	0	538	1,814	571
AMP, F40, INDUSTRIAL	96	0.65	0	0	0	0	0	0	34	34	672	437
AMP, F40, POLYWRAP	48	0.65	17	0	0	0	0	0	0	0	0	0
AMP, F40, LOUVERED	48	0.65	0	0	0	0	0	0	0	0	454	0
AMP, F40, INDUSTRIAL	48	0.65	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, INDUSTRIAL	360	0.58	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, INDUSTRIAL	270	0.59	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, LOUVERED	180	0.58	1,512	0	0	1,361	756	0	0	0	0	680
AMP, F96-75W, INDUSTRIAL	90	0.59	0	0	0	37	0	0	406	0	0	1,661
ILDING TOTALS			16,257	3,901	5,470	4,761	13,444	4,788	3,931	4,782	14,708	10,614

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			111	311	500	512	720	722	723	724	725	762
AMP, F40, LAY-IN	192	0.57	165	248	11,806	2,394	0	0	5,779	1,981	6,027	0
AMP, F40, POLYWRAP	192	0.57	2,807	0	1,569	10,320	0	0	0	0	0	2,477
AMP, F40, LOUVERED	192	0.57	6,770	0	30,960	7,183	0	660	0	0	4,954	0
AMP, F40, INDUSTRIAL	192	0.57	0	0	0	0	0	0	0	0	0	0
AMP, F40, LOUVERED	144	0.61	0	0	0	0	0	0	0	0	0	0
AMP, F40, INDUSTRIAL	144	0.61	0	0	0	0	0	0	0	0	0	0
AMP, F40, LAY-IN	96	0.65	0	34	0	0	0	0	0	0	0	0
AMP, F40, POLYWRAP	96	0.65	739	773	0	1,142	0	739	2,789	34	302	7,862
AMP, F40, LOUVERED	96	0.65	202	0	67	3,662	5,779	0	0	806	0	0
AMP, F40, INDUSTRIAL	96	0.65	0	0	0	0	0	0	403	403	538	0
AMP, F40, POLYWRAP	48	0.65	168	0	0	0	0	0	0	0	67	0
AMP, F40, LOUVERED	48	0.65	0	0	0	0	0	0	0	0	0	0
AMP, F40, INDUSTRIAL	48	0.65	0	336	0	17	0	0	0	0	0	0
AMP, F96-75W, INDUSTRIAL	360	0.58	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, INDUSTRIAL	270	0.59	0	0	0	0	0	1,328	0	0	0	0
AMP, F96-75W, LOUVERED	180	0.58	0	0	0	0	0	151	0	3,326	0	0
AMP, F96-75W, INDUSTRIAL	90	0.59	0	0	0	37	0	0	0	0	0	0
ILDING TOTALS			10,851	1,390	44,402	24,755	5,779	2,879	8,971	6,551	11,888	10,339

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			769	738	746	754	1,101	1,102	1,105	1,106	1,178	1,270
AMP, F40, LAY-IN	192	0.57	1,321	0	0	0	0	0	4,954	330	0	0
AMP, F40, POLYWRAP	192	0.57	0	0	0	165	1,073	0	0	413	0	4,211
AMP, F40, LOUVERED	192	0.57	0	0	0	660	1,734	2,477	0	0	0	0
AMP, F40, INDUSTRIAL	192	0.57	0	0	0	0	0	0	0	248	0	0
AMP, F40, LOUVERED	144	0.61	0	0	0	0	0	0	0	0	0	0
AMP, F40, INDUSTRIAL	144	0.61	0	0	0	0	0	0	0	0	0	0
AMP, F40, LAY-IN	96	0.65	0	0	0	0	0	0	0	0	0	0
AMP, F40, POLYWRAP	96	0.65	101	403	1,142	0	0	0	0	0	0	0
AMP, F40, LOUVERED	96	0.65	0	941	403	0	0	0	0	0	0	0
AMP, F40, INDUSTRIAL	96	0.65	403	0	0	0	0	0	0	0	0	0
AMP, F40, POLYWRAP	48	0.65	252	0	0	0	0	0	0	0	0	0
AMP, F40, LOUVERED	48	0.65	0	0	0	0	0	0	0	0	0	0
AMP, F40, INDUSTRIAL	48	0.65	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, INDUSTRIAL	360	0.58	8,467	0	0	0	0	302	0	0	0	0
AMP, F96-75W, INDUSTRIAL	270	0.59	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, LOUVERED	180	0.58	0	0	0	1,814	302	0	0	983	0	0
AMP, F96-75W, INDUSTRIAL	90	0.59	0	0	0	0	0	0	0	0	0	0
ILDING TOTALS			10,544	1,344	1,546	2,640	3,109	2,779	4,954	1,974	0	4,211

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			1,271	2,322	2,320	2,333	2,354	2,527	2,528	2,529	2,536	2,588
AMP, F40, LAY-IN	192	0.57	0	0	0	0	0	2,559	0	0	0	0
AMP, F40, POLYWRAP	192	0.57	0	0	413	0	0	660	0	0	0	0
AMP, F40, LOUVERED	192	0.57	0	0	0	0	0	7,018	0	0	0	826
AMP, F40, INDUSTRIAL	192	0.57	0	0	0	0	0	0	0	1,981	0	248
AMP, F40, LOUVERED	144	0.61	0	0	0	0	0	3,763	0	0	0	5,841
AMP, F40, INDUSTRIAL	144	0.61	0	0	0	0	0	14,321	0	0	0	0
AMP, F40, LAY-IN	96	0.65	0	0	0	0	0	0	0	0	0	0
AMP, F40, POLYWRAP	96	0.65	0	34	0	571	269	638	269	2,486	336	0
AMP, F40, LOUVERED	96	0.65	0	0	0	0	0	370	0	0	0	6,048
AMP, F40, INDUSTRIAL	96	0.65	0	0	0	2,520	0	0	0	0	0	4,469
AMP, F40, POLYWRAP	48	0.65	0	0	0	0	0	0	0	0	0	0
AMP, F40, LOUVERED	48	0.65	0	0	0	0	0	1,075	0	0	0	0
AMP, F40, INDUSTRIAL	48	0.65	0	0	0	0	0	0	0	0	0	638
AMP, F96-75W, INDUSTRIAL	360	0.58	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, INDUSTRIAL	270	0.59	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, LOUVERED	180	0.58	1,663	0	0	0	0	0	0	0	0	756
AMP, F96-75W, INDUSTRIAL	90	0.59	0	0	0	0	0	0	0	0	0	0
ILDING TOTALS			1,663	34	413	3,091	269	30,404	269	4,468	336	18,825

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			5,000	5,804	5,805	5,808	5,838	5,849	5,852	5,854	5,855	5,858
AMP, F40, LAY-IN	192	0.57	0	7,761	3,137	2,394	8,999	6,109	3,468	7,265	5,944	0
AMP, F40, POLYWRAP	192	0.57	991	2,642	0	4,458	0	0	2,064	0	0	0
AMP, F40, LOUVERED	192	0.57	0	0	0	0	0	0	0	0	0	0
AMP, F40, INDUSTRIAL	192	0.57	0	0	0	0	0	0	0	0	0	0
AMP, F40, LOUVERED	144	0.61	225	0	0	0	0	0	112	0	0	2,303
AMP, F40, INDUSTRIAL	144	0.61	0	0	0	0	0	0	0	0	0	0
AMP, F40, LAY-IN	96	0.65	0	168	0	0	0	134	0	0	0	0
AMP, F40, POLYWRAP	96	0.65	101	672	806	1,008	134	302	67	202	0	0
AMP, F40, LOUVERED	96	0.65	0	0	0	0	0	0	0	0	0	0
AMP, F40, INDUSTRIAL	96	0.65	0	269	403	0	0	0	0	0	0	0
AMP, F40, POLYWRAP	48	0.65	0	672	0	336	34	0	0	0	0	0
AMP, F40, LOUVERED	48	0.65	0	0	0	0	0	0	0	0	0	0
AMP, F40, INDUSTRIAL	48	0.65	806	0	0	0	0	0	0	0	0	0
AMP, F96-75W, INDUSTRIAL	360	0.58	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, INDUSTRIAL	270	0.59	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, LOUVERED	180	0.58	0	0	0	0	0	0	0	0	0	0
AMP, F96-75W, INDUSTRIAL	90	0.59	0	0	0	0	0	0	0	0	0	0
ILDING TOTALS			2,123	12,183	4,347	8,196	9,167	6,546	5,711	7,467	5,944	2,303

LIGHT FIXTURE TYPE	WATTS PER FIXTURE	FIXTURE UPGRADE FACTOR	FIXTURE WATT SAVINGS BUILDING NUMBER									
			5,859	5,863								
AMP, F40, LAY-IN	192	0.57	2,477	0								
AMP, F40, POLYWRAP	192	0.57	0	4,788								
AMP, F40, LOUVERED	192	0.57	0	0								
AMP, F40, INDUSTRIAL	192	0.57	0	0								
AMP, F40, LOUVERED	144	0.61	0	0								
AMP, F40, INDUSTRIAL	144	0.61	0	0								
AMP, F40, LAY-IN	96	0.65	34	0								
AMP, F40, POLYWRAP	96	0.65	134	0								
AMP, F40, LOUVERED	96	0.65	0	0								
AMP, F40, INDUSTRIAL	96	0.65	1,747	0								
AMP, F40, POLYWRAP	48	0.65	0	235								
AMP, F40, LOUVERED	48	0.65	0	0								
AMP, F40, INDUSTRIAL	48	0.65	0	0								
AMP, F96-75W, INDUSTRIAL	360	0.58	0	0								
AMP, F96-75W, INDUSTRIAL	270	0.59	0	0								
AMP, F96-75W, LOUVERED	180	0.58	0	0								
AMP, F96-75W, INDUSTRIAL	90	0.59	0	0								
ILDING TOTALS			4,392	5,024								

UNIQUE BLDG. NO.	TOTAL FIXTURE WATT SAVINGS	LIGHTING PERIOD HRS/YR	LIGHTING SAVINGS KWH/YR	NO. OF SIMILAR BLDGS.	TOTAL LIGHTING SAVINGS KWH/YR	TOTAL DEMAND SAVINGS KW-MO/YR	TOTAL COOLING SAVINGS KWH/YR	TOTAL HEATING PENALTY MMBTU/YR
1	16,258	2,080	33,817	0	33,817	195	2,616	21.4
8	3,901	2,080	8,114	0	8,114	47	628	5.1
11	5,470	2,080	11,378	5	68,268	394	5,281	43.3
12	4,761	2,080	9,903	2	29,709	171	2,298	18.8
13	13,444	2,080	27,964	0	27,964	161	2,163	17.7
51	4,788	2,080	9,959	0	9,959	57	770	6.3
54	3,932	2,080	8,179	0	8,179	47	633	5.2
55	4,782	2,080	9,947	0	9,947	57	770	6.3
56	14,708	2,080	30,593	0	30,593	176	2,367	19.4
58	10,614	2,080	22,077	0	22,077	127	1,708	14.0
111	10,851	2,080	22,570	0	22,570	130	1,746	14.3
311	1,391	2,080	2,893	0	2,893	17	224	1.8
500	44,402	2,080	92,356	2	277,068	1,598	21,434	175.6
512	24,755	2,080	51,490	2	154,470	891	11,950	97.9
720	5,779	2,080	12,020	1	24,040	139	1,860	15.2
722	2,878	2,080	5,986	0	5,986	35	463	3.8
723	8,971	2,080	18,660	1	37,320	215	2,887	23.7
724	6,550	2,080	13,624	0	13,624	79	1,054	8.6
725	11,888	2,080	24,727	0	24,727	143	1,913	15.7
762	10,339	2,080	21,505	3	86,020	496	6,655	54.5
769	10,544	2,080	21,932	1	43,864	253	3,393	27.8
738	1,344	2,080	2,796	1	5,592	32	433	3.5
746	1,545	2,080	3,214	0	3,214	19	249	2.0
754	2,639	2,080	5,489	0	5,489	32	425	3.5
1101	3,109	1,040	3,233	9	32,330	373	2,501	20.5
1102	2,779	1,040	2,890	4	14,450	167	1,118	9.2
1105	4,954	1,040	5,152	1	10,304	119	797	6.5
1106	1,974	1,040	2,053	1	4,106	47	318	2.6
1178	0	1,040	0	3	0	0	0	0.0
1270	4,211	2,080	8,759	4	43,795	253	3,388	27.8
1271	1,663	2,080	3,459	4	17,295	100	1,338	11.0
2322	34	1,040	35	3	140	2	11	0.1
2320	413	1,040	430	16	7,310	84	566	4.6
2333	3,091	1,040	3,215	7	25,720	297	1,990	16.3
2354	269	1,040	280	1	560	6	43	0.4
2527	30,404	2,080	63,240	0	63,240	365	4,892	40.1
2528	269	2,080	560	0	560	3	43	0.4
2529	4,467	2,080	9,291	0	9,291	54	719	5.9
2536	336	2,080	699	2	2,097	12	162	1.3
2588	18,826	2,080	39,158	0	39,158	226	3,029	24.8
5000	2,123	2,080	4,416	0	4,416	25	342	2.8
5804	12,184	2,080	25,343	0	25,343	146	1,961	16.1
5805	4,346	2,080	9,040	0	9,040	52	699	5.7
5808	8,196	2,080	17,048	0	17,048	98	1,319	10.8
5838	9,167	2,080	19,067	3	76,268	440	5,900	48.3
5849	6,545	2,080	13,614	2	40,842	236	3,160	25.9
5852	5,711	2,080	11,879	0	11,879	69	919	7.5
5854	7,467	2,080	15,531	0	15,531	90	1,201	9.8
5855	5,944	2,080	12,364	2	37,092	214	2,869	23.5
5858	2,303	2,080	4,790	0	4,790	28	371	3.0
5859	4,392	2,080	9,135	0	9,135	53	707	5.8
5863	5,023	2,080	10,448	1	20,896	121	1,617	13.2
TOTALS:					1,498,140	9,191	115,900	949.3

APPENDIX D

NON-RECOMMENDED ECO CALCULATIONS

APPENDIX E

(EEAP) LIGHTING STUDY SURVEY - SCOPE OF WORK AND REVIEW COMMENTS

APPENDIX E
SCOPE OF WORK AND REVIEW COMMENTS

TABLE OF CONTENTS

DETAILED SCOPE OF WORK
CONTRACT NO. DACAC63-94-D-0015
DELIVERY ORDER NO.

1. The Architect-Engineer (A-E) shall furnish all services, material, supplies, plant, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified project for design in accordance with the original basic contract and this Detailed Scope of Work. Appendix "A" of the basic contract shall be followed for performance requirements for A-E services. Where this Detailed Scope of Work conflicts with Appendix "A", this Detailed Scope of Work shall govern.

INSTALLATION	PROJECT TITLE
Fort Bliss, TX	(EEAP) Lighting Survey Study

2. The work and other related data and services required in this Delivery Order shall be accomplished within the time schedule required, in accordance with the subject stated above and scope of work described in paragraph 3 below. The schedule for delivery of data to the Contracting Officer is in calendar days as follows:

	DELIVERY SCHEDULE
a. Interim Submittal(s) and Related data for Studies (See Annex A for Number of Copies)	75 calendar days after receipt of signed D.O.
b. Pre-Final Submittal(s) (12 copies)	85 calendar days after approval of Interim submittal
c. Final Submittal (original and All Data Developed under this submital)	100 calendar days after approval of the Pre-final

(See Annex "A" page A-1 for Government Furnished Items)

3. The items of work included in this Delivery Order shall be in accordance with criteria furnished at the Scoping Conference held on April 21, 1994 at Fort Bliss, TX. The services to be provided shall include, but not be limited to, the following Scope of Work.

a. Items of Work: (See the enclosed General and Detailed Scope of Work).

1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

1.1 Perform a limited site survey of specific buildings or areas to collect all data required to evaluate the specific ECOs included in this study.

1.2 Evaluate specific ECOs to determine their energy savings potential and economic feasibility.

1.3 Provide project documentation for recommended ECOs as detailed herein.

1.4 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. GENERAL

2.1 This study is limited to the evaluation of the specific buildings, systems, or ECOs listed in Annex A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study.

2.3 For the buildings, systems or ECOs listed in Annex A, all methods of energy conservation as relates to lighting, as well as its effects on HVAC systems, and which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The study shall consider the use of all lighting sources applicable to each building, system, or ECO, including all effects lighting system changes may have on HVAC systems.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from DAIM-FDF-U, dated 10 Jan 1994 establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP, or O&M funding, and determining in coordination with installation personnel the appropriate packaging and implementation approach for all feasible ECOs.

2.6.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.6.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. The Commanding Officer or authorized representative at the installation will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this contract. This individual will be the installation representative.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Public Works and Logistics (DPWL) before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey.

c. Proposed working hours.

d. Support requirements from the Director of Public Works and Logistics.

3.7.2 Exit. The exit interview shall briefly describe the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Public Works and Logistics.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), labor, supervision and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a Savings to Investment Ratio greater than 1.25 and a simple payback period of less than ten years. The overall project and each discrete part of the project shall have an SIR greater than 1.25. All projects meeting the above criteria shall be arranged as specified in paragraph 2.6.1 and shall be provided with programming documentation. Programming documentation shall consist of a DD Form 1391, life cycle cost analysis (LCCA) summary sheet(s) (with necessary backup data to verify the numbers presented), and a Project Development Brochure (PDB). A life cycle cost analysis summary sheet shall be developed for each ECO and for the overall project when more than one ECO are combined. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs.

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate or payback period, but which have an SIR greater than 1.25 shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.6.2 and shall be provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

a. O & M Energy Projects: An O&M Energy project is one that results in needed maintenance or repair to an existing facility, or replaces a failed or failing existing facility, and also results in energy savings. The criteria are similar to the criteria for ECIP projects, ie, $300,000 construction cost, SIR $\geq$ 1.25, and simple payback period of less than ten years. In addition, if the project would replace a system or equipment that is considered 'failed or failing' due solely to obsolete technology or inefficiency, the equipment to be replaced must have been in use for at least three years; and the simple payback period must be three years or less.

b. Low Cost/No Cost Projects. These are projects which the Director of Public Works and Logistics (DPWL) can perform using his resources. Documentation shall be as required by the DPWL.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. The Detailed Scope of Work is contained in Annex A.

7. WORK TO BE ACCOMPLISHED.

7.1 Perform a Limited Site Survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms as part of the report. Light levels shall be measured under typical operating conditions for all areas or spaces being evaluated. The requirements for color rendition and current maintenance and relamping practices shall be noted for consideration in the evaluations. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.2 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in Annex A. These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions and engineering equations shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. Construction cost estimates shall be provided and shall break out the costs associated with rehab work (architectural, electrical, mechanical) where applicable. Existing and proposed light levels shall be compared with levels recommended by the Illumination Engineering Society (IES) or the Corps of Engineers Architectural and Engineering Instructions (AEI) for the applicable space and activity. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data.

7.3 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph 7.4.1, the AE will be advised of the DEH's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per par 7.4.2.

7.4 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and shall be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included.The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel.

Slides or view graphs showing the results of the study to date shall be used during the presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the Director of Public Works and Logistics, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.4.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a.All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par 5.3.

b.All ECOs which were analysed shall be grouped into two listings, recommended and non-recommended, each arranged in order of descending SIR. These lists may be subdivided by building or area as appropriate for the study.

The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the Director of Public Works and Logistics to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.4.2 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph 7.4.1 shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects:

1) Backup information as specified in paragraph 5.1

2) For any recommendation that would require a different layout of fixtures, a one-line drawing of the area with circuiting and switching is required.

d. Appendices to include as a minimum:

1) Energy cost development and backup data

2) Detailed calculations

3) Cost estimates

4) Computer printouts (where applicable)

5) Scope of Work

ANNEX A

DETAILED SCOPE OF WORK

FY94 LIGHTING SURVEY, FORT BLISS, TEXAS

1. All facilities to be investigated in this study are located on Fort Bliss in El Paso, Texas.

2. The General Scope of Work outlines requirements for the study and the report; and the detailed scope of work lists the specific areas to be studied. If any conflicts arise between the General and the Detailed scopes of work, the Detailed Scope of Work shall govern.

3. The work consists of identifying and evaluating energy conservation opportunities (ECOs) for lighting systems in specific facilities. A list of suggested ECOs is provided in Annex D. The ECOs in Annex D are to be evaluated as applicable for the buildings listed in Annex E.

4. Annex E has been tentatively arranged into groups of similar buildings so that the results of one building may be applied to all buildings in the same group. The AE will be required to verify and adjust the groupings by a walkthrough of all buildings. Buildings in the UNIQUE group must, of course, be evaluated individually.

5. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The final report for this study shall be due not later than 180 days after Notice to Proceed.

MILESTONE	PERCENT OF CONTRACT AMOUNT AUTHORIZED FOR PAYMENT
Entry Interview	10
Completion of Field Work	25
Receipt of Interim Submittal	75
Completion of Interim Presentation & Review	85
Receipt of Final Report	100

6. The installation representative for this contract will be Mr. Joe Mathis, Energy Manager, Directorate of Public Works and Logistics for Fort Bliss.

7. Government-Furnished Information: The following documents will be furnished to the AE:

a. As-built drawings (as available) of buildings/systems listed in Annex E.

b. Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994.

c. ETL 1110-3-282, Energy Conservation

d. TM 5-800-2, Cost Estimates, Military Construction

e. AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

f. Architectural and Engineering Instructions, Design Criteria, Chapter 12, Electrical Criteria, 9 December 1991

g. The latest MCP Index

8. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

9. Direct Distribution of Submittals: The AE shall make direct distribution of correspondence, minutes, report submittals, and responses to comments as indicated by the following schedule:

AGENCY	CORRESPONDENCE	EXECUTIVE SUMMARIES	REPORTS	FIELD NOTES
Commander US Army Air Defense Artillery Center & Fort Bliss ATTN: ATZC-ISB-E (Mathis) Fort Bliss, TX, 79916-0058	1	3	3	1*
Commander US Army Training and Doctrine Command ATTN: ATBO-GFE (Mr Dancy) Fort Monroe, VA, 23651	-	1	1	-
Commander U. S. Army Engineer District, Fort Worth ATTN: CESWF-ED-MP (Mr.Champagne) PO Box 17300 Fort Worth, TX, 76102 - 0300	1	3	3	1*
Commander USAED, Southwest ATTN: CESWD-PP-MM (Mr West) 1114 Commerce Street Dallas, TX, 75242 - 0216	-	1	1	-
Commander USAED, Mobile ATTN: CESAM-EN-CM (Battaglia) PO Box 2288; Mobile, AL 36628	1	1	1	-
Commander US Army Corps of Engineers ATTN: CEMP-ET (Mr Gentil) 20 Massachusetts Avenue NW Washington, DC, 20314 - 1000	-	1	-	-
Commander US Army Logistics Evaluation Agency ATTN: LOEA-PL (Mr Keath) New Cumberland Army Depot New Cumberland, PA, 17070 - 5007	-	1	-	-

* Field Notes submitted in final form at interim submittal.

ANNEX B

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

   o Total Annual Energy Used.

   o Source Energy Consumption.

   Electricity - KWH, Dollars, BTU
   Fuel Oil - GALS, Dollars, BTU
   Natural Gas - THERMS, Dollars, BTU
   Propane - GALS, Dollars, BTU
   Other - QTY, Dollars, BTU

4. Reevaluated Projects Results.

5. Energy Conservation Analysis.

   o ECOs Investigated.

   o ECOs Recommended.

   o ECOs Rejected. (Provide economics or reasons)

   o ECIP Projects Developed. (Provide list)*

   o Non-ECIP Projects Developed. (Provide list)*

   o Operational or Policy Change Recommendations.

* Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

6. Energy and Cost Savings.

   o Total Potential Energy and Cost Savings.

   o Percentage of Energy Conserved.

   o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

ANNEX C

REQUIRED DD FORM 1391 DATA

To facilitate ECIP project approval, the following supplemental data shall be provided:

a. In title block clearly identify projects as "ECIP."

b. Complete description of each item of work to be accomplished including quantity, square footage, etc.

c. A comprehensive list of buildings, zones, or areas including building numbers, square foot floor area, designated temporary or permanent, and usage (administration, patient treatment, etc.).

d. List references, and assumptions, and provide calculations to support dollar and energy savings, and indicate any added costs.

(1) If a specific building, zone, or area is used for sample calculations, identify building, zone or area, category, orientation, square footage, floor area, window and wall area for each exposure.

(2) Identify weather data source.

(3) Identify infiltration assumptions before and after improvements.

(4) Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

e. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

f. An ECIP life cycle cost analysis summary sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

g. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period.

h. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

i. For each temporary building included in a project, separate documentation is required showing (1) a minimum 10-year continuing need, based on the installation's annual real property utilization survey, for active building retention after retrofit, (2) the specific retrofit action applicable and (3) an economic analysis supporting the specific retrofit.

j. Nonappropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

k. Any requirements required by ECIP guidance dated 10 Jan 1994 and any revisions thereto. Note that unescalated costs/savings are to be used in the economic analyses.

l. The five digit category number for all ECIP projects except for Family Housing is 80000. The category code number for Family Housing projects is 71100.

ANNEX D

LIGHTING ENERGY CONSERVATION OPPORTUNITIES

REDUCE/ENHANCE LIGHTING

- o Remove unneeded lamps or fixtures
- o Reduce indoor lighting where illumination exceeds recommended levels
- o Increase daylighting
- o Lower light fixtures
- o Improve reflection and dispersion with light-colored ceilings and walls

IMPROVE LIGHTING CONTROLS

- o Install occupancy sensors to control lighting
- o Install additional switches to control lighting arrangements

IMPROVE LIGHTING EFFFICIENCY

- o Replace incandescent exit sign fixtures with LED fixtures
- o Replace incandescent lamps in exit signs with compact fluorescent lamps
- o Replace standard fluorescent lamps with energy-conserving lamps
- o Replace standard fluorescent ballasts with electronic ballasts
- o Install new reflectors in existing fluorescent fixtures
- o Replace existing fluorescent fixtures with new fixtures having efficient reflectors, electronic ballasts, and energy-conserving lamps
- o Use more efficient lighting source, ie, upgrade from incandescent to fluorescent, from fluorescent to HID, from mercury vapor to high pressure sodium, etc

FY94 FORT BLISS LIGHTING SURVEY
UNIQUE BUILDINGS

BLDG NO	DESCRIPTION	AREA, SF	FLOORS
1	Post Headquaters	29,237	4
8	Admin (Historical)	4,845	2
13	Admin (Historical)	21,467	3
50	Admin General Purpose	9,291	1
51	Library	5,284	1
54	Fire Station	8,987	2
55	Admin Testing	6,692	2
56	Communications Center	17,775	2
58	Field Printing Plant	17,520	1
111	Accounting (Historical)	21,162	2
311	Theater	10,303	1
762	General Instruction	14,378	1
769	Applied Instruction	14,294	1
1103	Self Service Supply Cent	16,000	1
1250	Engineer Field Maint Shop	29,093	1
2004	Clothing Sales Store	5,027	1
2031	Laundry	52,913	1
2518	Motor Repair Shop	20,077	1
2527	Supply Operations Bldg.	65,563	1
2528	General Purpose Warehouse	24,791	1
2529	Motor Repair Shop	13,200	1
2588	GM Maintenance Facility	85,833	1

FY94 FORT BLISS LIGHTING SURVEY
UNIQUE BUILDINGS

BLDG NO	DESCRIPTION	AREA, SF	FLOORS
5000	Museum	13,185	1
5804	Classroom Facility	13,176	1
5805	Classroom Facility	11,607	1
5808	Classroom Facility	16,139	1
5852	General Instruction	5,235	1
5858	General Instruction	4,623	1
5859	Applied Instruction	9,236	1

FY94 FORT BLISS LIGHTING SURVEY
BUILDING GROUPS

UILDING TYPE	BLDG NO	DESCRIPTION	AREA,SF	FLOORS
istorical-1	11	Admin General Purpose	7,404	2
istorical-1	12	Admin General Purpose	7,404	2
istorical-1	112	Admin General Purpose	7,404	2
istorical-1	113	Admin General Purpose	7,404	2
istorical-1	114	Admin General Purpose	7,404	2
istorical-1	115	Admin General Purpose	7,404	2
istorical-1	116	Admin General Purpose	7,404	2
istorical-1	117	Admin General Purpose	7,404	2
istorical-1	118	Admin General Purpose	7,404	2
istorical-2	500	Admin General Purpose	57,740	4
istorical-2	503	Admin general Purpose	57,740	4
istorical-2	504	Admin General Purpose	57,740	4
istorical-2	512	Admin General Purpose	57,740	4
istorical-2	515	Admin General Purpose	57,740	4
istorical-2	516	Admin General Purpose	57,740	4
Shop-1	2511	Motor Repair Shop	18,281	1
Shop-1	2512	Motor Repair Shop	18,281	1
Shop-1	2513	Motor Repair Shop	18,281	1
Shop-1	2516	Motor Repair Shop	18,281	1
Shop-1	2519	Motor Repair Shop	18,281	1
Shop-2	2514	Motor Repair Shop	22,635	1
Shop-2	2515	Motor Repair Shop	22,635	1

FY94 FORT BLISS LIGHTING SURVEY
BUILDING GROUPS

BUILDING TYPE	BLDG NO	DESCRIPTION	AREA, SF	FLOORS
Training-1	720	Applied Instruction	7,700	1
Training-1	721	Applied Instruction	7,700	1
Training-2	722	Applied Instruction	13,934	2
Training-2	723	Applied Instruction	13,934	2
Training-2	724	Applied Instruction	13,934	2
Training-2	725	Applied Instruction	13,934	2
Training-3	738	Applied Instruction	13,860	2
Training-3	739	Applied Instruction	13,860	2
Training-3	740	Applied Instruction	13,860	2
Training-3	745	Applied Instruction	13,860	2
Training-3	746	Applied Instruction	13,860	2
Training-3	747	Applied Instruction	13,860	2
Training-3	754	Appplied Instruction	13,860	2
Training-3	755	Applied Instruction	13,860	2
Training-3	756	Applied Instruction	13,860	2
Training-4	2320	General Instruction	6,966	1
Training-4	2321	General Instruction	6,966	1
Training-4	2326	General Instruction	6,966	1
Training-4	2327	General Instruction	6,966	1
Training-4	2330	General Instruction	6,966	1
Training-4	2331	General Instruction	6,966	1
Training-4	2332	General Instruction	6,966	1

FY94 FORT BLISS LIGHTING SURVEY
BUILDING GROUPS

UILDING TYPE	BLDG NO	DESCRIPTION	AREA,SF	FLOORS
raining-4	2333	General Instruction	6,966	1
raining-4	2335	General Instruction	6,966	1
raining-4	2336	General Instruction	6,966	1
raining-4	2337	General Instruction	6,966	1
raining-4	2340	General Instruction	6,966	1
raining-4	2341	General Instruction	6,966	1
raining-4	2342	General Instruction	6,966	1
raining-4	2343	General Instruction	6,966	1
raining-4	2344	General Instruction	6,966	1
raining-4	2347	General Instruction	6,966	1
raining-4	2350	General Instruction	6,966	1
raining-4	2351	General Instruction	6,966	1
raining-4	2352	General Instruction	6,966	1
raining-4	2353	General Instruction	6,966	1
raining-4	2354	General Instruction	6,966	1
raining-4	2356	General Instruction	6,966	1
raining-4	2357	General Instruction	6,966	1
raining-4	2536	General Instruction	6,966	1
raining-4	2537	General Instruction	6,966	1
raining-4	2538	General Instruction	6,966	1
raining-5	2322	Applied Instruction	9,917	1
raining-5	2323	Applied Instruction	9,917	1

FY94 FORT BLISS LIGHTING SURVEY
BUILDING GROUPS

BUILDING TYPE	BLDG NO	DESCRIPTION	AREA, SF	FLOORS
Training-5	2324	Applied Instruction	9,917	1
Training-5	2352	Applied Instruction	9,917	1
Training-6	2334	Applied Instruction	7,025	1
Training-6	2345	Applied Instruction	7,025	1
Training-6	2346	Applied Instruction	7,025	1
Training-6	2355	Applied Instruction	7,025	1
Training-7	5838	General Instruction	6,616	1
Training-7	5843	General Instruction	6,555	1
Training-7	5849	General Instruction	6,452	1
Training-7	5850	General Instruction	6,532	1
Training-7	5851	General Instruction	6,368	1
Training-7	5853	General Instruction	6,272	1
Training-7	5854	General Instruction	6,594	1
Training-7	5855	General Instruction	6,215	1
Training-7	5856	General Instruction	6,366	1
Training-7	5857	General Instruction	6,249	1
Training-7	5860	General Instruction	6,367	1
Training-8	5863	General Instruction	4,001	1
Training-8	5864	General Instruction	3,981	1
WH-1	1101	General Purpose Warehouse	15,960	1
WH-1	1105	General Purpose Warehouse	15,960	1
WH-1	1106	General Purpose Warehouse	15,960	1

FY94 FORT BLISS LIGHTING SURVEY
BUILDING GROUPS

BUILDING TYPE	BLDG NO	DESCRIPTION	AREA,SF	FLOORS
WH-1	1109	General Purpose Warehouse	15,960	1
WH-1	1110	General Purpose Warehouse	15,960	1
WH-1	1111	General Purpose Warehouse	15,960	1
WH-1	1112	General Purpose Warehouse	15,960	1
WH-1	1113	General Purpose Warehouse	15,960	1
WH-1	1114	General Purpose Warehouse	15,960	1
WH-1	1115	General Purpose Warehouse	15,960	1
WH-1	1116	General Purpose Warehouse	15,960	1
WH-1	1117	General Purpose Warehouse	15,960	1
WH-1	1118	General Purpose Warehouse	15,960	1
WH-1	1119	General Purpose Warehouse	15,960	1
WH-1	1120	General Purpose Warehouse	15,960	1
WH-1	1121	General Purpose Warehouse	15,960	1
WH-1	1122	General Purpose Warehouse	15,960	1
WH-1	1123	General Purpose Warehouse	15,960	1
WH-1	1124	General Purpose Warehouse	15,960	1
WH-2	1102	General Purpose Warehouse	16,000	1
WH-2	1104	General Purpose Warehouse	16,000	1
WH-3	1177	General Storehouse	9,267	1
WH-3	1178	General Storehouse	9,267	1
WH-3	1179	General Storehouse	9,267	1
WH-3	1180	General Storehouse	9,267	1

FY94 FORT BLISS LIGHTING SURVEY
BUILDING GROUPS

UILDING TYPE	BLDG NO	DESCRIPTION	AREA, SF	FLOORS
H-3	1181	General Storehouse	9,267	1
H-3	1270	General Storehouse	9,267	1
H-3	1271	General Storehouse	9,267	1
H-3	1272	General Storehouse	9,267	1
H-3	1273	General Storehouse	9,267	1
H-3	1274	General Storehouse	9,267	1
WH-3	1275	General Storehouse	9,267	1
WH-3	1276	General Storehouse	9,267	1
WH-3	1277	General Storehouse	9,267	1
WH-3	1278	General Storehouse	9,267	1
WH-3	1279	General Storehouse	9,267	1

Interim Submittal Review Letter From Fort Bliss

DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY AIR DEFENSE ARTILLERY CENTER AND FORT BLISS
FORT BLISS, TEXAS 79916-0058

REPLY TO
ATTENTION OF

Directorate of Public
Works and Logistics

RECEIVED
MAR 0 6 1995
HZ

SUBJECT: Fort Bliss Lighting Retrofit

Mr. C. A. Pieper
Huitt-Zollars Inc.
512 Main Street, Suite 1500
Fort Worth, Texas 76102

Dear Mr. Pieper:

(1) The interim report on the above referenced project was excellent and provided the information required for planning and economic verification. However, we wish to submit the project for funding as six smaller projects.

I have grouped the 134 buildings in six groups and included them as an attachment.

(2) Request you recalculate the project costs, savings to investment ratios, paybacks, etc., based upon the revised groupings using the material costs from the Defense General Supply Center "Energy Efficient Lighting" catalog dated February 1994.

(3) For labor costs please contact Mr. George Lambert, Chief, Contract Management Division, Directorate of Public Works and Logistics at (915) 568-2479. He can supply standard labor costs from the job order contracting (JOC) catalog.

(4) I would also like to inform you of the urgency of receiving the revised life cycle costing data as the deadline for submission of these projects for funding is April 1, 1995.

Thank you in advance for your prompt response.

Sincerely,

Paul L. Kay
Colonel, U.S. Army
Director, Directorate of Public
Works and Logistics

Attachment

LIGHTING PROJECTS

GROUP	TOTAL BUILDINGS	BUILDINGS
1	19	Historical Old Post Area: 1, 8, 11, 12, 13, 51, 54, 55, 56, 58, 111, 112, 113, 114, 115, 116, 117, 118, 2004
2	6	Peoples Plaza (500 Area): 500, 503, 504, 512, 515, 516
3	17	High Bay Instruction (700 Area): 720, 721, 722, 723, 724, 725, 738, 739, 740, 745, 746, 747, 754, 755, 756, 762, 769
4	31	Metal Warehouse Buildings (2300 Area): 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357
5	28	Maintenance and Abernethy Park: 2518, 2527, 2528, 2529, 2536, 2537, 2538, 2588, 5000, 5804, 5805, 5808, 5838, 5843, 5849, 5850, 5851, 5852, 5853, 5854, 5855, 5856, 5857, 5858, 5859, 5860, 5863, 5864
6	33	Directorate of Public Works and Logistics Shops and Warehouses: 1101, 1102, 1103, 1105, 1106, 1111, 1112 1113, 1114, 1115, 1116, 1117, 1118, 1119, 1120, 1122, 1123, 1124, 1177, 1178, 1179, 1180, 1181, 1270, 1271, 1272, 1273, 1274, 1275, 1276, 1277, 1278, 1279

Responses to Interim Submittal Review Letter From Fort Bliss
3/9/95

ITEM	RESPONSE
1.	Concur with comment, will proceed as directed.
2.	Concur with comment, will proceed as directed.
3.	Concur with comment, will proceed as directed.
4.	I understand situation and will try to move up schedule.

Interim Submittal Review Comments From USAED, Mobile

MOBILE DISTRICT PROJECT REVIEW COMMENTS		Date: 27 Jan 95	Page 1 of 1
To: Richard Champagne Fort Worth District, CESWF-ED-MP	From: (Section) CESAM-EN-DM (Reviewer) A. Battaglia 334-690-2618		
Project: FY94 Lighting Study Location: Fort Bliss, Texas	Year: FY-94	Line Item No.:	
Type of Action: Interim Submittal Review			

ITEM NO.	DRAWING NO. OR PAR. NO.	COMMENTS	REVIEW ACTION
		I have two comments to add to Mr. Naiden's comments. The first is similar to the comment I made on the Corpus Christi and Red River Army Depot lighting surveys. The second also has to do with estimates.	
1.	General	I want to comment on estimating and Life Cycle Cost Analyses, and I want to differentiate between the Contractor's overhead costs and the Government's overhead costs. So, at the risk of insulting the AE's intelligence, I have attached an example of a cost estimate from a previous ESAP study. On this example, all of the contractor's costs for materials, labor, (equipment rental and sub-contracting if needed), overhead, profit, and contingencies are shown and summed into a total construction cost at the lower right hand corner of the sheet. This is the value that should be used in Line 1A, CONSTRUCTION COST, of the LCCA Summary Sheet. Line 1B, SIOH, is the government's cost for administering the contract; it should be equal to 5.5% of Line 1A. Line 1C, DESIGN COST, is the government's cost for design; use 6% of Line 1A except for very small or very complex projects. Please make necessary revisions.	
2.	General	Warren Naiden, who has been in on the design of lighting renovation projects in the Mobile District; and Bill Stein, the Energy Manager at Fort Huachuca, AZ, both have told me that recent lighting renovation projects had come in at considerably lower costs than originally estimated. This was apparently due to the fact that the succesful bidders were not General Contractors, but lighting suppliers who employed installers. A lot of markup and subcontracting costs were avoided. Suggest this approach be explored. If it looks promising, the cost estimates should be backed up with written quotations.	

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MOBILE DISTRICT OFFICE PROJECT REVIEW COMMENTS	DATE:25 JAN 95	PAGE 1 of 2

TO: EN-DM Tony Battaglia	FROM: (SECTION): Electrical (CESAM-EN-CE) (REVIEWER): Warren E. Neiden, Jr.,PE (334) 694-4031

PROJECT: EEAP LIGHTING SURVEY STUDY LOCATION: FORT ELISS, TX	Year: FY-	Line Item No.
Type of Action: INTERIM REPORT		ELECTRICAL REVIEW

Item No.	Drawing No. or Par. No.	COMMENTS	Review Action
1.	Appendix A	This report should clearly indicate that the monthly electrical demand usage is well above the Minimum Contract of 10,000 kW to actually claim the Demand Charge Savings in all of the proposed ECO's.	
2.	Page 7	Paragraph C.4. references an Appendix D for a cost comparison of "replacing lamps and ballast" vs "new fixtures" , but Appendix D is shown as "Non-recommended ECO Calculations" with no calculations included. Please coordinate and correct accordingly.	
3.	Page 7	Paragraph C.7. states "Because of the reduction of potential energy & cost savings, Installation of Occupancy Sensors to turn off lights was rejected". This appears to be based on areas that more lighting is required, therefore higher energy consumption. This would seem to increase the benefit of occupancy sensors, not negate it. Provide calculations to support this assumption.	
4.	Page 7	Paragraph C.6. states that the ECO concerning the Installation of Compact Fluorescent lamps in incandescent fixtures was rejected due to no guarantee of future retrofits. If energy can can be saved and it cost justified, it should be analyzed. Future retrofits is an administrative problem therefore the owner must make this decision. Coordinate and correct accordingly.	
5.	General	This report should reflect either "MBTU" or "MMBTU", not both. This is confusing. Correct accordingly.	
6.	General	Equation on page A-1 & A-6 is missing the "=" sign.	
7.	Page A-8	The average monthly cost of natural gas should not include the non-heating months, especially since the gas rates are lower. The average cost shown does not reflect the actual cost incurred Consult weather records to determine the actual months to include to achieve a more realistic cost to use in your analysis	
8.	Appendix B	Table of Contents, Item B; Correct spelling of "Efficiency".	
9.	General	This report references Appendix G throughout as to "data sheets" but although it is indicated in the Index , it was not included.	
10.	Page B-2	Sample calculation in D.(a) indicates 192 Watts for a 4-lamp fluorescent fixture, but attached manufacturers comparison uses 180 Watts for the same type of fixture. Explain this difference correct calculations accordingly.	
11.	Page C-1	Indicate how the Electrical Energy Savings of 902,096 kWH/yr was derived.	
12.	Page C-6	Provide lighting calculations and fixture details of proposed lighting design to support cost assumptions indicated and indicate the type and quality of fixtures utilized.	
13.	Page C-8	Show how the $100/fixture was obtained for the values of both Fluorescent & HPS fixtures indicated in item #13.	
14.	Page C-15	Paragraph C. indicates "areas which are currently overlighted". How was this determined? Was this based on functional changes in various parts of the building or miss labeling of these areas. Also, how will this affect the flexibility of the building for future occupants and functions. Clarify and correct accordingly.	

Interim Submittal Review Comments From USAED, Mobile (Continued)

MOBILE DISTRICT OFFICE PROJECT REVIEW COMMENTS	DATE:25 JAN 95	PAGE 2 of 2
PROJECT: EEAP LIGHTING SURVEY STUDY LOCATION: FORT BLISS, TX		ELECTRICAL REVIEW

Item No.	Drawing No. or Par. No.	COMMENTS	Review Action
15.	Page C-21	Provide fixture details of proposed lighting design to support cost assumptions indicated and indicate the type and quality of fixtures proposed. Also, our data indicates that it is less expensive to just clean the fixture and replace the lamps and ballast than to replace the whole fixture. Clarify and explain how this conclusion was reached.	

Responses to Interim Review Comments From USAED, Mobile
3/9/95

ITEM	RESPONSE
1. (page E-27)	Concur, changed as directed.
2. (page E-27)	Noted, however was unable to obtain written quotations from anyone without construction drawings and specifications.
1. (page E-28)	Noted, see page 12.
2.	Noted, see ECO-2 on page C-15.
3.	ECOs 1 and 2 will reduce the lighting load in every building between 35 to 79 percent (see fixture upgrade factors, pages C-2 and C-16). Experience gained in previous studies document that with these kinds of load reductions make installation of occupancy sensors economically infeasible (see EEAP Lighting Survey Study - Red River Army Depot and EEAP Lighting Survey Study - Corpus Christi Army Depot).
4.	Noted. See page 2, *Install Compact Fluorescent Lamps in Incandescent Fixtures.*
5.	Noted. While the writer uses "MMBTU" to represent 1,000,000 BTUs, the computer program used for the life cycle cost estimates, LCCID, uses "MBTU" for this same purpose. The program does not give the option to change the units from "MBTU" to "MMBTU". However, careful comparison of the life cycle cost estimate summary sheets and the ECO calculations should make it clear to the reader that these terms are used interchangeably in this instance.
6.	Noted. This was done on purpose just to show the formulas used and the units to be obtained.
7.	Using only the heating months of November through February, the average cost of gas from page A-7 would be $2.029/MCF. Using this value in the avoided cost of gas calculation of page A-6, the 'revised' avoided cost would be $2.314/MCF. This is an increase of only 2 percent over the value of $2.268/MCF used in the study. The total gas energy penalty calculated in this study was 1,488 MCF/yr (see page 6, item E). Applying 'revised' avoided gas cost to the total gas penalty would lower the total cost savings of $482,522/yr by only $67 (see page 6, item E). Since this is a relatively insignificant amount, the report was not revised as suggested by the reviewer.
8.	Noted and corrected.
9.	Appendix G was completed and distributed at the interim submittal as directed on page E-11.
10.	Advance catalog data for a two lamp, F40, standard magnetic ballast of the type commonly provided in older fixtures such as were found at fort bliss (Advance #VQM-2S40-TP) shows an input wattage of 96 watts. Assuming that a four lamp fixture has two of these ballasts, the total input wattage to the fixture would be 192 W as was used in the calculations.

ITEM	RESPONSE
11.	The total electrical savings (KWH/yr) shown on page C-1 was found by adding the total lighting energy savings and the total cooling energy savings from page C-13.
12.	It is beyond the scope of work of this study to provide design calculations for new lighting systems in the 132 buildings studied. However, sample replacement fixture data was included in Appendix F and the estimated quantities of each type of replacement fixture was included in all the revised cost estimates in the study. See 'fixture quantity factors' on page C-2 for an explanation of how the replacement fixture quantities were determined.
13.	See revised cost estimates. Budget prices were obtained from local suppliers and used in these estimates.
14.	Noted, paragraph C revised on page C-15.
15.	See answer to comments number 12, 13 and 14 above.

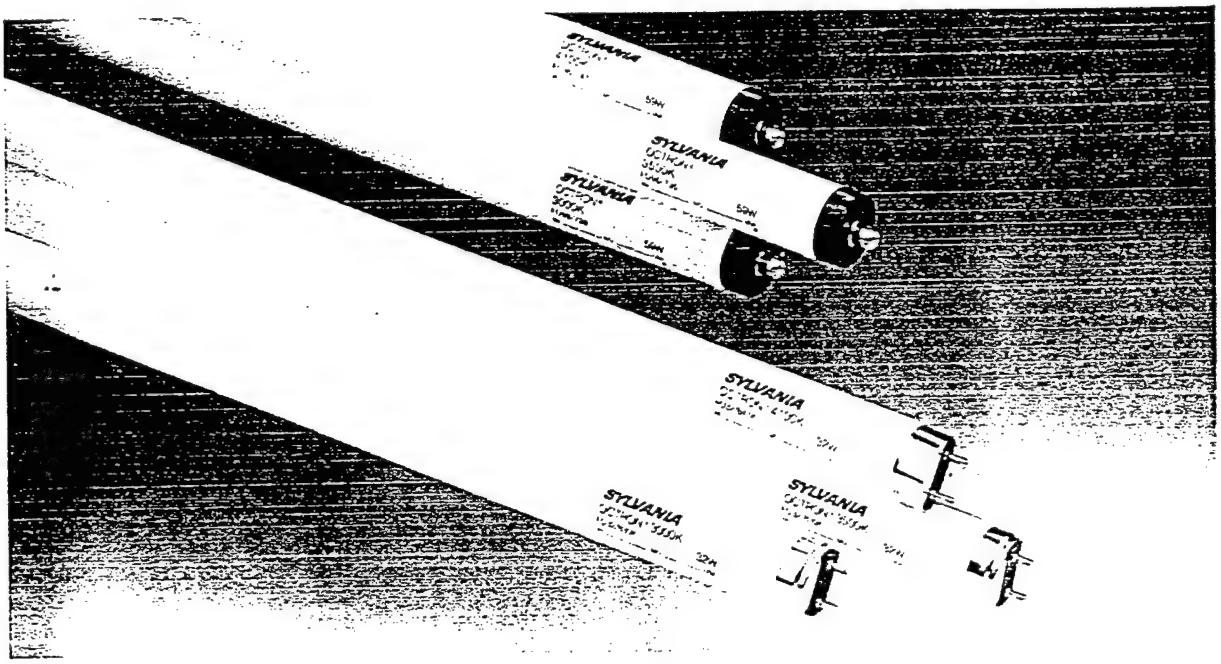
APPENDIX F

SAMPLE PRODUCTS

APPENDIX F
SAMPLE PRODUCTS

TABLE OF CONTENTS

OCTRON®
Fluorescent Lamps



The Widest Range of T8 Lamps Available

Through its OCTRON® line OSRAM SYLVANIA offers more T8 lamp options than any other manufacturer. This gives architects, lighting designers, engineers, contractors and other specifiers the opportunity to select exactly the right mix of lamps to meet the precise requirements of an application.

All OCTRON lamps have a 20,000 hour average rated life when operated on rapid start ballasts. Lamps are rated at 15,000 hours when operated on instant start ballasts. (These figures are based on three hours of operation per start. Ratings will improve as burning cycles increase. In a typical 10 hour per day application, for example, life ratings on rapid start or instant start ballasts are increased by 35 percent.) Because long life means less frequent lamp replacement and smaller lamp inventories, maintenance costs can be substantially reduced.

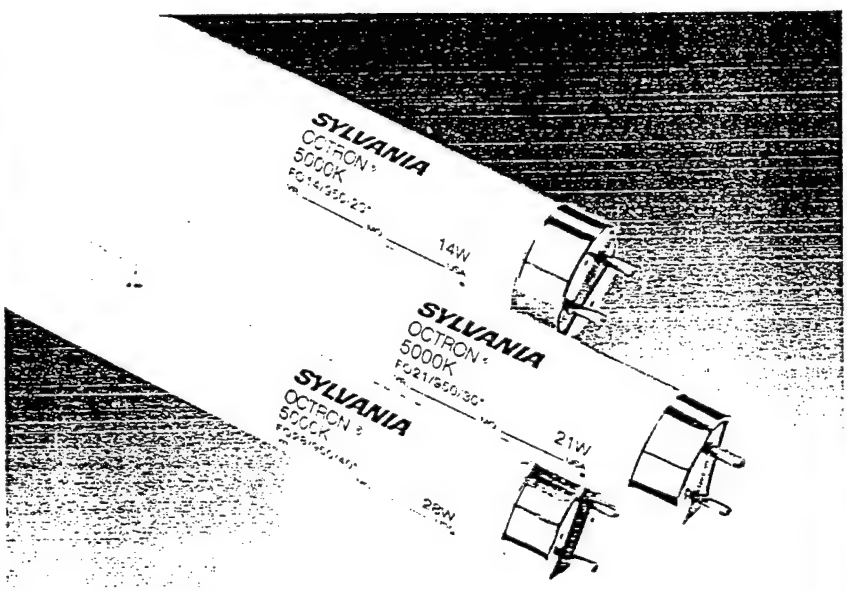
OCTRON® Bipin Linear Lamps

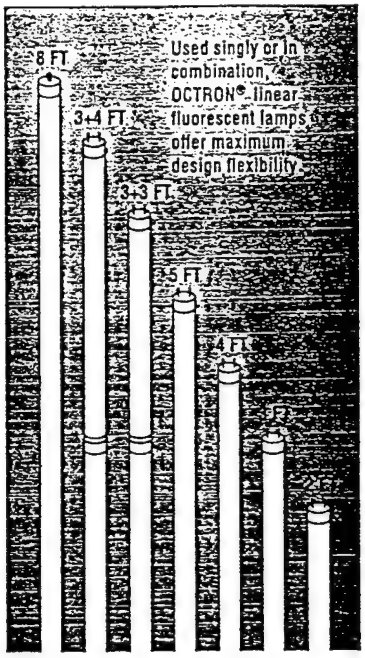
OCTRON bipin linear fluorescent lamps are available in four length/wattage combinations—2-foot (17W), 3-foot (25W), 4-foot (32W) and 5-foot (40W). This means there is an OCTRON T8 lamp to replace any commonly available bipin T12 lamp in any standard linear fluorescent fixture. OCTRON 700 Series lamps are available in four color temperatures— 3000K, 3500K, 4100K and 5000K— and have a color rendering index of 75. The 800 Series lamps come in 3000K, 3500K and 4100K colors and have an exceptional CRI of 85.

OCTRON® Single Pin Lamps

The OCTRON family includes an 8-foot single pin T8 lamp. When used in combination with an electronic ballast OCTRON FO96T8 lamps can replace F96T12 systems—saving over 90 watts per two-lamp fixture. The 15,000 hour average rated life of this innovative lamp is 25 percent longer than ordinary F96T12 lamps. In addition, the argon fill gas in OCTRON FO96T8 lamps is less temperature sensitive than the krypton gas commonly used in F96T12/SS lamps. This improves light output in applications where cold air circulates. Available in 700 Series (75 CRI) and 800 Series (85 CRI) versions with a choice of 3000K, 3500K and 4100K colors.

T8 Linear Fluorescent Lamps





OCTRON 900 Series lamps are the only T8 lamps available that are suitable for color critical applications.

OCTRON® 900 Series Lamps

The OCTRON® 900 Series offers the industry's only full color spectrum T8 fluorescent lamps. These high performance lamps are designed for a wide variety of color critical applications. Their CRI of 90 is the highest of any fluorescent lamp and they feature a color temperature of 5000K. The American National Standards Institute has specified 5000K light sources for color evaluation and comparisons. 5000K was chosen because it is the average color of daylight—an almost universal light source. OCTRON 900 Series lamps have a wide range of uses in graphic arts, textile and quality control applications where accurate color evaluation and comparisons are essential. They are also ideal for backlighting displays and translucent signs. OCTRON 900 Series lamps are available in the standard 2-foot, 3-foot, 4-foot and 5-foot lamp lengths as well as special 20-inch, 30-inch and 40-inch versions. Wattages range from 14 to 40 watts. For increased flexibility, different sizes of OCTRON 900 Series lamps may be operated on a single multi-lamp instant start electronic ballast with uniform lamp life.

Understanding OCTRON® T8 Technology

OCTRON T8 lamps can be operated effectively on rapid start magnetic and rapid start electronic ballasts. However, specific elements of OCTRON T8 technology are designed to achieve maximum performance on high frequency, instant start electronic ballasts.

The primary benefit of running OCTRON T8 lamps on electronic ballasts is the ability to use less energy to produce a given amount of light. The energy savings come from the fact that an electronic ballast drives OCTRON T8 lamps at high frequency—20,000 Hz—compared to 60 Hz for a standard magnetic ballast. The increased frequency improves light output by up to 12 percent, allowing OCTRON lamps to provide dramatic energy cost savings while producing the same output as fluorescent T12 lamps. For even more savings, OCTRON fluorescent lamps may be operated with as little as 140 milliamps of current on instant start electronic ballasts.

OCTRON®
OCTRON® CURVALUME®
T8 Fluorescent Lamps

OCTRON® 700 Series Linear T8 Fluorescent Lamps

Watts	Bulb	Nominal Length (in.)	Base	Item Number	Ordering Abbreviation	Average Rated Life (hours)	Initial Lumens	Color Temp.	CRI
17	T-8	24	Medium Bipin	21849	FO17/730	20000	1325	3000K	75
17	T-8	24	Medium Bipin	21832	FO17/735	20000	1325	3000K	75
17	T-8	24	Medium Bipin	21831	FO17/741	20000	1325	4100K	75
25	T-8	36	Medium Bipin	21851	FO25/730	20000	2125	3000K	75
25	T-8	36	Medium Bipin	21817	FO25/735	20000	2125	3500K	75
25	T-8	36	Medium Bipin	21829	FO25/741	20000	2125	4100K	75
32	T-8	48	Medium Bipin	21852	FO32/730	20000	2850	3000K	75
32	T-8	48	Medium Bipin	21823	FO32/735	20000	2850	3500K	75
32	T-8	48	Medium Bipin	21824	FO32/741	20000	2850	4100K	75
32	T-8	48	Medium Bipin	21809	FO32/750	20000	2850	5000K	75
40	T-8	60	Medium Bipin	21853	FO40/730	20000	3600	3000K	75
40	T-8	60	Medium Bipin	21820	FO40/735	20000	3600	3500K	75
40	T-8	60	Medium Bipin	21827	FO40/741	20000	3600	4100K	75
59	T-8	96	Single Pin	21854	FO96/730	15000	5700	3000K	75
59	T-8	96	Single Pin	21839	FO96/735	15000	5700	3500K	75
59	T-8	96	Single Pin	21840	FO96/741	15000	5700	4100K	75

OCTRON® 800 Series Linear T8 Fluorescent Lamps

Watts	Bulb	Nominal Length (in.)	Base	Item Number	Ordering Abbreviation	Average Rated Life (hours)	Initial Lumens	Color Temp.	CRI
17	T-8	24	Medium Bipin	21903	FO17/830	20000	1400	3000K	85
17	T-8	24	Medium Bipin	21904	FO17/835	20000	1400	3500K	85
17	T-8	24	Medium Bipin	21905	FO17/841	20000	1400	4100K	85
25	T-8	36	Medium Bipin	21913	FO25/830	20000	2225	3000K	85
25	T-8	36	Medium Bipin	21914	FO25/835	20000	2225	3500k	85
25	T-8	36	Medium Bipin	21915	FO25/841	20000	2225	4100K	85
32	T-8	48	Medium Bipin	21923	FO32/830	20000	3000	3000K	85
32	T-8	48	Medium Bipin	21924	FO32/835	20000	3000	3500K	85
32	T-8	48	Medium Bipin	21925	FO32/841	20000	3000	4100K	85
36	T-8	48	Medium Bipin	21930	FO36/830	20000	3450	3000K	85
36	T-8	48	Medium Bipin	21931	FO36/835	20000	3450	3500K	85
36	T-8	48	Medium Bipin	21932	FO36/841	20000	3450	4100K	85
40	T-8	60	Medium Bipin	21938	FO40/830	20000	3775	3000K	85
40	T-8	60	Medium Bipin	21939	FO40/835	20000	3775	3500K	85
40	T-8	60	Medium Bipin	21940	FO40/841	20000	3775	4100K	85
59	T-8	96	Single Pin	21897	FO96/830	15000	6000	3000K	85
59	T-8	96	Single Pin	21898	FO96/835	15000	6000	3500K	85
59	T-8	96	Single Pin	21899	FO96/841	15000	6000	4100K	85

OCTRON® 900 Series Linear T8 Fluorescent Lamps

Watts	Bulb	Nominal Length (in.)	Base	Item Number	Ordering Abbreviation	Average Rated Life (hours)	Initial Lumens	Color Temp.	CRI
14	T-8	20	Medium Bipin	21868	FO14/950/20	20000	750	5000K	90
17	T-8	24	Medium Bipin	21871	FO17/950/24	20000	800	5000K	90
21	T-8	30	Medium Bipin	21869	FO21/950/30	20000	1000	5000K	90
25	T-8	36	Medium Bipin	21872	FO25/950/36	20000	1250	5000K	90
28	T-8	40	Medium Bipin	21870	FO28/950/40	20000	1400	5000K	90
32	T-8	48	Medium Bipin	21860	FO32/950/48	20000	1675	5000K	90
40	T-8	60	Medium Bipin	21979	FO40/950/60	20000	2200	5000K	90

Ordering Information

OCTRON® CURVALUME® 700 Series T8 Fluorescent Lamps

Watts	Bulb	Nominal Length (in.)	Base	Item Number	Ordering Abbreviation	Average Rated Life (hours)	Initial Lumens	Color Temp.	CRI
16	T-8	10.5	Medium Bipin	21792	FB016/730	20000	1225	3000K	75
16	T-8	10.5	Medium Bipin	21800	FB016/735	20000	1225	3500K	75
16	T-8	10.5	Medium Bipin	21802	FB016/741	20000	1225	4100K	75
24	T-8	16.5	Medium Bipin	21794	FB024/730	20000	2025	3000K	75
24	T-8	16.5	Medium Bipin	21610	FB024/735	20000	2025	3500K	75
24	T-8	16.5	Medium Bipin	21604	FB024/741	20000	2025	4100K	75
31	T-8	22.5	Medium Bipin	21795	FB031/730	20000	2750	3000K	75
31	T-8	22.5	Medium Bipin	21807	FB031/735	20000	2750	3500K	75
31	T-8	22.5	Medium Bipin	21806	FB031/741	20000	2750	4100K	75
31	T-8	22.5	Medium Bipin	21819	FB031/750	20000	2550	5000K	75
32	T-8	22.5	Medium Bipin	21967	FB032/730/6	20000	2650	3000K	75
32	T-8	22.5	Medium Bipin	21963	FB032/735/6	20000	2650	3500K	75
32	T-8	22.5	Medium Bipin	21969	FB032/741/6	20000	2650	4100K	75

OCTRON® CURVALUME® 800 Series T8 Fluorescent Lamps

Watts	Bulb	Nominal Length (in.)	Base	Item Number	Ordering Abbreviation	Average Rated Life (hours)	Initial Lumens	Color Temp.	CRI
16	T-8	10.5	Medium Bipin	21834	FB016/830	20000	1300	3000K	85
16	T-8	10.5	Medium Bipin	21835	FB016/835	20000	1300	3500K	85
16	T-8	10.5	Medium Bipin	21836	FB016/841	20000	1300	4100K	85
24	T-8	16.5	Medium Bipin	21874	FB024/830	20000	2125	3000K	85
24	T-8	16.5	Medium Bipin	21875	FB024/835	20000	2125	3500K	85
24	T-8	16.5	Medium Bipin	21876	FB024/841	20000	2125	4100K	85
31	T-8	22.5	Medium Bipin	21877	FB031/830	20000	2900	3000K	85
31	T-8	22.5	Medium Bipin	21878	FB031/835	20000	2900	3500K	85
31	T-8	22.5	Medium Bipin	21879	FB031/841	20000	2900	4100K	85
32	T-8	22.5	Medium Bipin	21970	FB032/830/6	20000	3000	3000K	85
32	T-8	22.5	Medium Bipin	21971	FB032/835/6	20000	3000	3500K	85
32	T-8	22.5	Medium Bipin	21972	FB032/841/6	20000	3000	4100K	85

Sample Specifications

OCTRON®

Lamps shall be SYLVANIA OCTRON* _____ (FO17, FO25, FO32, FO36*, FO40, FO96) having a T8 bulb and _____ (medium bipin, single pin**) bases. Lamps shall have a correlated color temperature of_____ (3000K, 3500K, 4100K, 5000K) and a color rendering index of _____ (75, 85). They are to be operated on _____ (magnetic rapid start, electronic instant start, electronic rapid start) ballasts.

Available only in 800 Series
***FO96 only*

OCTRON® CURVALUME®

Lamps shall be SYLVANIA OCTRON* CURVALUME* _____ (FBO16, FBO24, FBO31, FBO32*) having a _____ (1⅛", 6") leg spacing and medium bipin bases. Lamps shall have a correlated color temperature of _____ (3000K, 3500K, 4100K, 5000K) and a color rendering index of _____ (75, 85). They are to be operated on _____ (magnetic rapid start, electronic instant start, electronic rapid start) ballasts.

**FBO32 is the only CURVALUME lamp with 6" leg spacing*

OCTRON® 900 Series

Lamps shall be SYLVANIA OCTRON 900 Series fluorescent lamps having medium bipin bases. Lamps shall have a correlated color temperature of 5000K and a color rendering index of 90. Lamp lengths shall be _____ (20", 24", 30", 36", 40", 48", 60"). Lamps shall be operated on _____ (magnetic rapid start, electronic instant start, electronic rapid start) ballasts.

For Orders And General Information

OSRAM SYLVANIA National Customer Support Center, 18725 N. Union Street, Westfield, IN 46074

Industrial/Commercial Phone: 800/255-5042
Fax: 800/255-5043

Consumer Products Phone: 800/842-7010
Fax: 800/842-7011

Specialty Lamps Markets Phone: 800/762-7191
Fax: 800/762-7192

National Accounts:
Industrial/Commercial Phone: 800/562-4671
Consumer Products Phone: 800/562-4672
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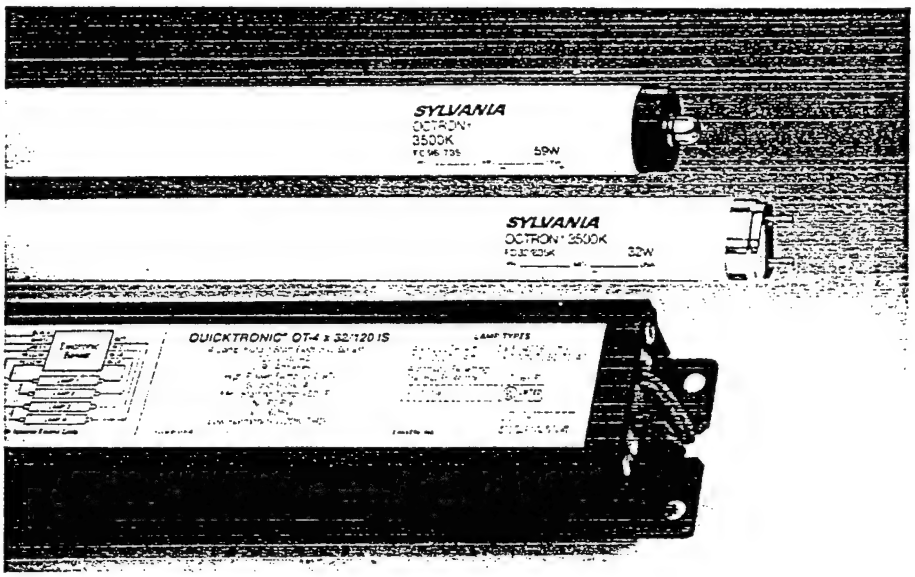
Electronic Lighting Systems
The System Solution

A Complete Range of Fluorescent Systems

OSRAM SYLVANIA offers a QUICKTRONIC® system to provide optimum performance with every OCTRON® and OCTRON® CURVALUME® T8 lamp. There are also QUICKTRONIC systems for DULUX® L and F96T12 lamps. All QUICKTRONIC systems have a high ballast factor and high frequency circuitry for maximum light output and efficiency with minimal lamp flicker. Multi-lamp ballasts power up to four lamps with parallel circuitry that keeps remaining lamps lit when one or more fails. QUICKTRONIC systems are ideal for either retrofit or new installations.



QUICKTRONIC® SYSTEM 32

QUICKTRONIC SYSTEM 32 is designed to use OCTRON 32W T8 fluorescent lamps and provides illumination equal to an F40T12 system with 40 percent less energy usage. It can also operate 17W, 25W and 40W T8 lamps, OCTRON CURVALUME lamps and 40W T5 twin lamps. QUICKTRONIC SYSTEM 32 is available in 120V and 277V versions to drive one, two, three and four-lamp systems.

OCTRON and OCTRON CURVALUME T8 lamps are available in 75, 85 and 90 CRI versions and provide energy savings, high luminous efficacy and excellent color rendition. The DULUX L 40W is a single ended twin tube lamp that provides nearly the same light output as a 4-foot linear lamp.

QUICKTRONIC® SYSTEM 36

QUICKTRONIC SYSTEM 36 is designed to operate OCTRON 36W T8 lamps. It provides up to 30 percent more lumen output than a standard 32W T8 system. It also operates DULUX L 39W twin tube fluorescent lamps. QUICKTRONIC SYSTEM 36 is a two-lamp system available in 120V and 277V versions.

OCTRON 36W T8 lamps are available in 3000K, 3500K and 4100K versions and have a CRI of 85. They provide exceptional luminous efficacy and energy efficiency. The DULUX L 39W single ended twin tube lamp provides nearly the same light output as a 4-foot linear lamp and has an efficacy of up to 81 lumens per watt.

QUICKTRONIC® SYSTEM 59

QUICKTRONIC SYSTEM 59 is designed to operate OCTRON FO96T8 lamps. It provides illumination equal to F96T12 lamps with 40 percent less energy usage. Because it is smaller and lighter than the F96T12 magnetic ballast it replaces, installation is easier and more flexible. QUICKTRONIC SYSTEM 59 is a two-lamp system available in 120V and 277V versions.

OCTRON FO96T8 lamps have a single pin base and are designed to replace F96T12 lamps. OCTRON FO96T8 lamps come in three color temperatures—3100K, 3500K and 4100K and are available in 75 CRI and 85 CRI versions.

QUICKTRONIC® SYSTEMS

QUICKTRONIC® SYSTEM 17

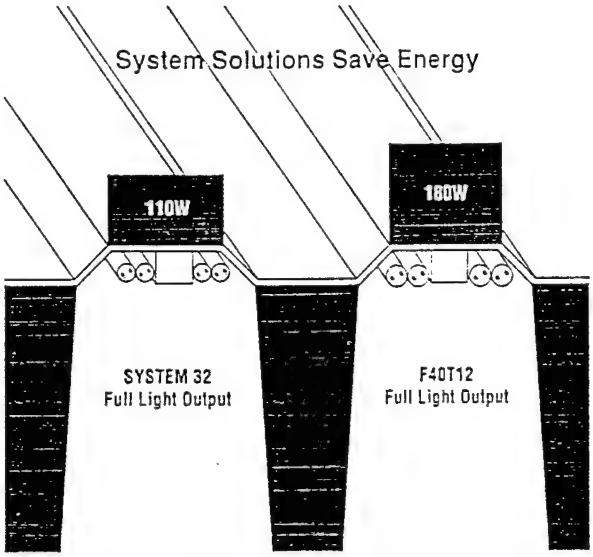
QUICKTRONIC® SYSTEM 17 is designed to operate OCTRON® 17W T8 and OCTRON® CURVALUME® 16W lamps with full energy efficiency, high lumen output and low harmonic distortion. QUICKTRONIC SYSTEM 17 is a three-lamp system available in 120V and 277V versions.

OCTRON 17W T8 and OCTRON CURVALUME 16W lamps are available in both 75 and 85 CRI versions. When used in QUICKTRONIC SYSTEM 17 they provide energy savings, high luminous efficacy and excellent color rendering.

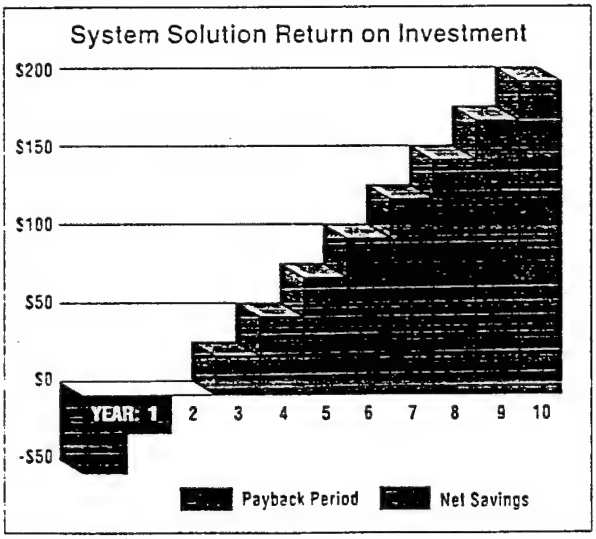
QUICKTRONIC® SYSTEM 96

QUICKTRONIC SYSTEM 96 is designed to operate both standard and energy saving SYLVANIA F96T12 lamps and F96T12/HO lamps. It provides high lumen output, extremely efficient operation and up to 20 percent energy savings when compared to older magnetic ballasts. Other T12, SLIMLINE and H.O. lamps can also be driven. QUICKTRONIC SYSTEM 96 is a two-lamp system available in 120V and 277V versions.

SYLVANIA F96T12 SLIMLINE and F96T12 High Output lamps are available in a range of colors with up to 80 CRI. Standard and energy saving versions are available.



Power Input vs. Light Output for QUICKTRONIC® System 32 Compared to F40T12 System



10 Year Payback on QUICKTRONIC® System 32 vs. F40T12 System

QUICKTRONIC® SYSTEM 55

QUICKTRONIC SYSTEM 55 is designed to operate DULUX® L 55W twin tube fluorescent lamps. It provides up to 50 percent more lumen output than standard T5 twin lamps with no loss in system efficiency. This is the ideal system for high lumen indirect, cove and 2x2 fixtures. QUICKTRONIC SYSTEM 55 is offered as a one or two-lamp system in 120V and 277V versions.

DULUX L 55W twin tube lamps provide up to 50 percent more light output than standard T5 twin lamps. DULUX L lamps offer an efficacy of up to 81 lumens per watt and are available in 3000K, 3500K and 4100K versions.

OSRAM SYLVANIA
System Solutions

Ordering Information

QUICKTRONIC® Electronic Systems for Fluorescent Lamps

Item Number	Ordering Abbreviation	Voltage (VAC)	Lamp Type	No of Lamps	Input Wattage (W)	Ballast Factor	%THD
49255	QT1X32/120IS	120	32W-T8	1	31	.93	<20
49257	QT1X32/277IS	277	32W-T8	1	31	.93	<20
49270	QT2X32/120IS	120	32W-T8	2	62	.95	<20
49268	QT2X32/277IS	277	32W-T8	2	62	.95	<20
49258	QT3X32/120IS	120	32W-T8	3	88	.93	<20
49260	QT3X32/277IS	277	32W-T8	3	88	.93	<20
49265**	QT4X32/120IS	120	32W-T8	4	110	.87	<20
49263	QT4X32/277IS	277	32W-T8	4	110	.87	<20
49262	QT2X35/120IS	120	35W-T8	2	78	1.05	<20
49267	QT2X35/277IS	277	35W-T8	2	78	1.05	<20
49340	QT2X59/120IS	120	59W-T8	2	105	.85	<20
49346	QT2X59/277IS	277	59W-T8	2	105	.85	<20
49252	QT3X17/120IS	120	17W-T8	3	50	.95	<20
49253	QT3X17/277IS	277	17W-T8	3	50	.95	<20
49250	QT2X96/120IS	120	F96T12	2	135	.68	<20
49254	QT2X96/277IS	277	F96T12	2	135	.68	<20
49255	QT2X96/120HO	120	F96T12/HO	2	210	.87	<20
49251	QT2X96/277HO	277	F96T12/HO	2	210	.87	<20
49267	QT2X55/120IS	120	55W Dulux L	2	110	1.00	<20
49268	QT2X55/277IS	277	55W Dulux L	2	110	.91	<20

ACCUTRONIC™ Low Voltage DC Electronic Systems for Compact Fluorescent Lamps

Item Number	Ordering Abbreviation	Voltage (VAC)	Lamp Type	No of Lamps	Input Wattage (W)	Ballast Factor	%THD
49401	AT7-9/12	12	7-9W Dulux SE & DE	1	10	1.00	
49400	AT7-9/24	24	7-9W Dulux SE & DE	1	10	1.00	

POWERTRONIC™ Electronic Systems for HID Lamps

Item Number	Ordering Abbreviation	Voltage (VAC)	Lamp Type	No of Lamps	Input Wattage (W)	Ballast Factor	%THD
49300	PT-DE 70/120	120	70W HQI-DE	1	80	1.00	<10
49301	PT-DE 70/277	277	70W HQI-DE	1	80	1.00	<10

For Orders And General Information

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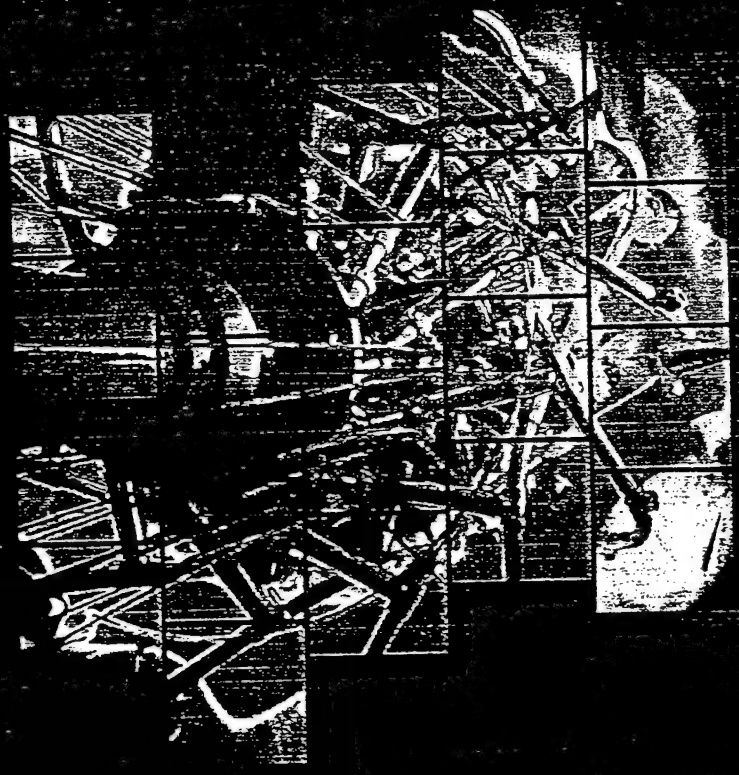
Fax: 800/762-7192

National Accounts:
Industrial/Commercial Phone: 800/562-4671
Consumer Products Phone: 800/562-4672
Fax: 800/562-4674

University of Wisconsin–Madison/Extension

Mechanical Engineering and Energy Course Schedule



January–June 1995

Department of Engineering Professional Development
College of Engineering

For More Information or To Enroll

To request brochures for particular courses or to enroll, complete the attached postpaid card and mail it.

Or fax it toll free to 800-442-4214 or 608-265-3448.

Or call toll free 800-462-0876 or 608-262-2061.

General Information

Fees Course fees generally cover a prepared set of notes, lunches, and refreshments, and may include a dinner, a text or special equipment use. Fees and course dates listed herein are subject to change. Fee discounts are often available when two or more people from the same organization attend a course.

Pre-payment Not Required Enroll now, and we'll bill you later. Or send a purchase order or check, payable to UW–Madison, to the Wisconsin Center, 702 Langdon Street, Madison, WI 53706. We also accept MasterCard, VISA and American Express.

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Save on Air Travel Your enrollment confirmation will include details on discounted airfares.

Continuing Education Units Upon successful completion of our continuing education courses you will earn a specified number of Continuing Education Units (CEU). Some courses listed in this brochure earn university credits.

Professional Development Degree This is an alternative advanced degree for practicing engineers. The courses described in this brochure can apply as credit toward this University of Wisconsin Professional Development degree. Call for details and qualifications.

Distance Education Because it is often more convenient for you, we offer several ways for you to take our courses at home or at work. See pages 12-15 for details.

For Course Schedules in Other Engineering Areas Call Us!

Course schedules are available in these areas:

Building Design and Construction
Civil and Environmental Engineering
Electrical Engineering, Electronics and Telecommunications
Manufacturing and Product and Process Engineering

Department of Engineering Professional Development

Industrial Energy Systems (EM4)

May 1–5, 1995 5208D

Successful industrial energy managers have cut energy indices by 25 percent or more. This course will provide methods to help you develop an appropriate energy index for measuring performance and controlling energy costs. You will review the basics of process energy analysis and compare theoretical, potential, and actual performance of industrial energy systems. Your learning will include the latest heat recovery technology, combustion equipment, adjustable speed drives and digital process controls. Plan to work with other energy managers in solving typical industrial energy problems. Topics for this course include:

- energy management performance analysis and forecasting
- process energy analysis techniques
- energy efficiencies of commonly used systems
- optimization of operation and control
- cost-effective retrofits
- latest technology for waste heat utilization
- energy-efficient designs, systems and components for replacement and new construction
- methods for analyzing potential savings.

Fee: $1145 Director: Keith Kempski

Building Energy Systems (EM3)

July 17–21, 1995 5238D

Developing Effective Energy/Environmental Programs (EM1)

September 11–15, 1995 5773D

HVAC Systems for Buildings

Piping Systems for HVAC

February 20–24, 1995 5015D

This course will develop your understanding of fluid systems encountered in air conditioning of buildings, and specifically of piping systems for water, steam, and refrigerants. Emphasis will be on understanding the factors that influence pipe sizing, balancing, and pump selection to meet the air-conditioning system needs.

Fee: $1095 Director: Harold Olsen

Direct Digital Controls for HVAC

February 27–March 3, 1995 5023D
in Las Vegas, Nevada

June 19–23, 1995 5028D
in Madison, Wisconsin

This course introduces you to the design and application of direct digital controls (DDC) for commercial and industrial HVAC systems. The course begins with a thorough discussion of the capabilities of system architecture and communication concepts, programming concepts, and performance of peripherals. The course then proceeds to apply DDC to the requirements of air conditioning equipment and distribution systems from packaged rooftop single zone to built-up dual fan VAV systems. Point selection and economic analysis are key points of discussion. The different programming concepts available today (line programming, menu or block programming, and graphical programming) will be discussed and demonstrated. The course concludes with a detailed presentation on the acquisition process, including plans, specifications, and project management. Sample specs and drawings are part of the course material.

Fee: $1145 Director: Charles Dorgan

Energy Management

Professionals in the energy field can participate in the Energy Management Diploma Program, which focuses on developing management abilities and establishing a workable energy management organization. Each course provides comprehensive coverage of a specific aspect of energy management. You can attend any one course or all, in a sequence convenient to you. Qualified individuals who complete all four courses and an exam may earn an energy management diploma.

This course exemplifies what I expect from your courses: technically proficient speakers who also provide enjoyable presentations.

Gerald Menefee
Director of Community Services
City of Gladstone, Missouri

For more information or to enroll, please call 800-462-0876.

Successful Energy Project Analysis and Selection (EM2)

March 6–10, 1995 5235D

To identify, evaluate or select effective energy conservation measures, you must understand where and how energy is used in your facility. You must analyze utility bills and rate schedules for opportunities to reduce costs. Finally, you must understand your company's investment criteria to ensure that recommended projects are funded. This course will help you develop an organized approach to energy data gathering and analysis in your facility. You will learn how to use key energy management tools—from a thorough and efficient walk-through energy audit to the latest microprocessor-based electronic data collection techniques. You will look at sources of energy use information—in-house technical personnel, consultants, and utility companies—studying the strengths and weaknesses of each and determining the best source of information for your facility. Help ensure good energy calculations and economic analyses by studying:

- what to include in effective energy audit reports
- what auditor experience is necessary
- how to use utility DSM programs
- what procedures and calculations to use
- useful instruments and measurements
- how to analyze utility rates and schedules
- how to calculate energy savings and benefits.

Fee: $1145 Director: Keith Kempski

Energy Auditing/ Analysis

These courses are part of a series that will help you to focus your technical experience on the skills required for auditing or analysis, rather than designing, various building and energy systems. Our auditing courses combine a mix of classroom lectures and on-site fieldwork. You gain both the theoretical background and the practical experience for understanding energy systems found in all types of buildings.

HVAC Systems and Controls

February 6–10, 1995 5234D

Improvements in HVAC systems and controls are unique because simple or complex changes often result in approximately the same level of performance improvement. Yet, investment costs and paybacks will vary substantially. This course will help you to understand your options and make the best decisions. You will analyze systems, evaluate performance and recommend improvements for comfort and energy conservation. Plan to study these topics and more:

- HVAC system characteristics
- psychrometrics and control of HVAC processes
- air distribution, comfort and indoor air quality
- successful variable air volume retrofit strategies
- temperature controls, energy management and direct digital controls.

The course will build upon material presented in our course, *Fundamentals of Energy Auditing.*

Fee: $1095 Director: Keith Kempski

Fundamentals of Energy Auditing

April 24–28, 1995 4670D

Auditing of commercial buildings demands skills different from those used with residential structures. This course teaches you a proven approach to doing energy audits. You will review basic systems—HVAC, plumbing, electrical, and building envelope—as they apply to small commercial buildings. Principal topics will include:

- building energy use fundamentals
- energy estimating methods
- HVAC and lighting system basics
- effective data collection and analysis techniques.

Fee: $995 Director: Don Schramm

Commercial/Industrial Energy Analysis

August 14–18, 1995 5239D

Subjects were covered well. I appreciated the ample opportunity to practice hands-on the subject material.

Jeffrey S. Nettesheim
Utility Engineer
Village of Germantown, Wisconsin

Mechanical Engineering and Energy Courses

Central Utility Plants

Improving Cooling Tower Operation and Cooling Water Treatment

January 4–6, 1995 5644D

Systems engineering and water treatment considerations for modern water cooling facility operations will be the emphasis for this intensive three-day course. You will study in-depth the causes and correction of water-related cooling system problems.
Fee: $795 Director: Jack Quigley

Boiler Plant Operation and Orientation

January 9–11, 1995 5645D

Increase your basic understanding of boiler plant operation and of boiler plant auxiliaries such as turbine systems.
Fee: $795 Director: Jack Quigley

Of all the seminars I've taken over the years, this was by far the best because the topic was thoroughly covered—not the usual superficial treatment.

Richard Yancey
Quality Assurance Consultant
I/N TEK
New Carlisle, Indiana

Cogeneration Technology

March 13–17, 1995 5016D

During the last 10 years, significant improvements in cogeneration equipment and cogeneration systems have been made. Today both large and small energy users can benefit from a cogeneration system. Given the increase in electrical demand, cogeneration can produce an economic payback of six months to two years for peak shaving or supplementary power. Longer term paybacks are possible for locations that need large reliable energy sources. This course focuses on concept design and preliminary equipment selection to aid you in decision making and rough plant layout. During the group design sessions you will make individual and group judgments, calculations, and decisions for a given application. Computer software for preliminary analysis will be provided.
Fee: $1295 Director: Harold Olsen

Basic Boiler Water Treatment

May 8–10, 1995 5646D

This course provides a basic understanding of low- to medium-pressure boilers for heating or process operations, and steam-generating systems and their components and operating problems. You'll gain a working knowledge of the methods available to protect this costly capital equipment from premature failure or damage by scaling, corrosion, and carryover.
Fee: $795 Director: Jack Quigley

Boiler Plant Optimization: Basic Concepts and Applications

June 5–8, 1995 5778D

This practical course presents the fundamental aspects of conventional fuel combustion, with emphasis on how these influence boiler plant operations.
Fee: $895 Director: Jack Quigley

For more information or to enroll, please call 800-462-0876.

the Watt Stopper

Applications

The Watt Stopper manufactures the most complete line of automatic lighting controls. A combination of Ultrasonic, Passive Infrared and Dual Technology sensors can be used to configure any application. For specific information on how the technologies work see "Passive Infrared Sensor Technology" , "Ultrasonic Technology", and "Dual Technology" sections under 'technical data'. Some of the most common uses are described here.

Office Buildings

The Watt Stopper occupancy sensors are the perfect product to control lighting in the office environment. With all three technologies, effective energy savings can be achieved in every space. Our recommendations are:

• OFFICES - WPIR, WI or WS series wall switches	15-70%	Savings
• OPEN OFFICE SPACES - CI-100, CI-200, W,1000A W2000A, DT-100L	5-25%	Savings
• CONFERENCE ROOMS - W500A, W1000A, DT-100L, CI-100	20-65%	Savings
• COMPUTER ROOMS - DT-100L, WPIR, CI-100	20-65%	Savings
• RESTROOMS - Ultrasonic sensors	30-75%	Savings
• CORRIDORS - CI-100-2, W2000H	30-60%	Savings

Colleges & Schools

The Watt Stopper occupancy sensors have been very successful in elementary, secondary, and college applications. For schools we recommend:

• LARGE CLASSROOMS - DT-100L, W2000A, CI-100, CI-200	20-75%	Savings
• SMALL CLASSROOMS - W1000A, CI-100, WPIR	0-75%	Savings
• CORRIDORS - CI-100-2, W2000H	30-60%	Savings
• RESTROOMS - Ultrasonic sensors	35-75%	Savings
• TEACHERS OFFICES - WPIR, WI or WS series wall switches	30-50%	Savings
• GYM'S AND MULTIPURPOSE - DT-100L, CI-100	35-70%	Savings

Retail & Hotels

The Watt Stopper occupancy sensors help you reduce energy costs while still meeting the special needs of your customers. For the most dramatic savings we recommend:

• STORAGE AREAS - DT-100L, Ultrasonic, WPIR, CI-100, CI-200	45-65%	Savings
• MEETING ROOMS - DT-100L, W500A, W1000A, CI-100, CI-200	40-65%	Savings
• WAREHOUSES - DT-100L, W2000A, CI-100, CI-200	50-75%	Savings

HVAC, EMS, Light Level & Misc

HVAC and Energy Management Systems can be used in combination with any and all Watt Stopper products. Every sensor can be used to turn lighting on and off in addition to producing information or signals for the other systems.

- HVAC - Use the DT-100L, CI-100 or CI-200 for independent "on" and/or independent "off" for any area.
- EMS - The Watt Stopper sensors can be used to control lighting loads independently or in conjunction with EMS systems.
- Light Level - The DT-100L, CI-100 and CI-200 have a separate output to isolate a circuit for light level control.
- Cold Storage, Outdoor applications: CB-100, CB-200

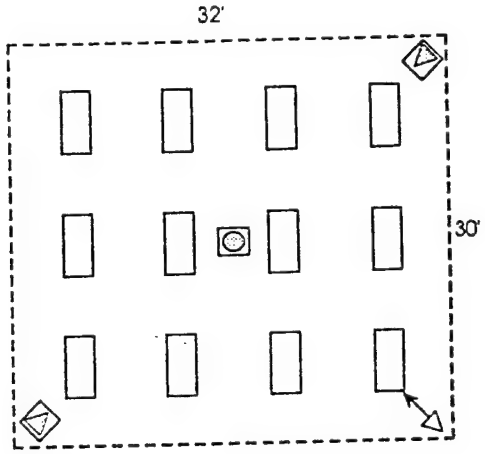
The Watt Stopper®, Inc.
2800 De La Cruz Blvd
Santa Clara, CA 95050
Tel: (408) 988-5331
Fax: (408) 988-5373
National Technical Support
Plano, Texas: (800) 879-8585

APPLICATION – OPEN OFFICE AREA

Ultrasonic, PIR, and Dual Technology Sensors in Open Office Area & Partitioned Offices

Application

1. Check square footage of area.
2. Use coverage templates.
3. Designing for smaller zones results in greater energy savings.
4. Make sure PIR sensors have clear view of the controlled area.
5. Specify time-delay to match activity level of the space.



Savings

(See enclosed "Timer Test Study")
For an open office area with
12 - 3 lamp fixtures = 1.44 Kw
x $.10 per Kwh = $.144 cost per hour

Save 4 hours per day Mon-Fri
Save 6.5 hours per weekend

Total hours saved = 26.5 hours x 52 weeks
= 1,378 hours per year

1,378 hour x $.144 cost per hour
= $198.43 ANNUAL SAVINGS

Payback/ROI

Ultrasonic sensor & power pack = $125.00
Installation = $60.00
Total Cost =$185.00
Payback = **11.2 Months**
ROI = **107%**

DT-100L & power pack = $160.00
Installation = $60.00
Total Cost =$220.00
Payback = **13.3 Months**
ROI = **90%**

2 - CI-100 sensors & power pack = $180.00
Installation = $90.00
Total Cost = $270.00
Payback = **16.3 Months**
ROI = **74%**

039_JC.2

**Sensor, power pack, and installation costs are approximate.

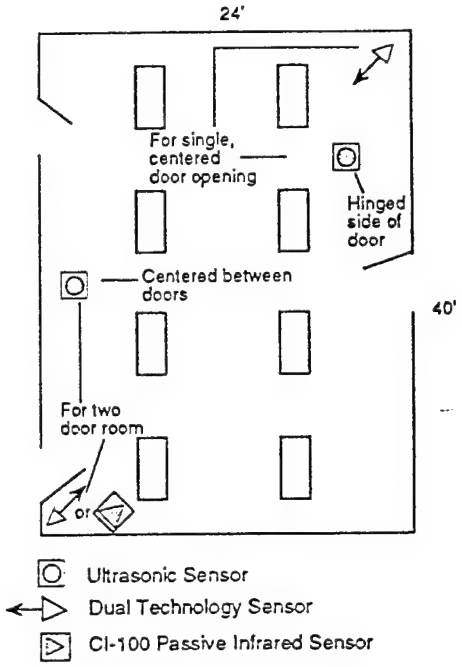
APPLICATION – COMMON AREA

Ultrasonic, PIR, and Dual Technology Sensors in Common Building Areas Larger Than 300 sq ft

Application

Conference rooms, computer rooms, maintenance areas, classrooms, vending areas, lunch rooms, copy rooms

1. Check square footage of area.
2. Use coverage templates.
3. Make sure PIR sensors have clear view of the controlled area.
4. Place sensor or "mask" lens so it does not "see" outside the room.
5. Specify time-delay and sensitivity to match activity level of the space.



Savings

8 - 176 Watt 2' x 4' Troffers
= 1.41Kw x $.10 per Kwh
= $.141 cost per hour

Save 4 hours per day Mon-Fri
Save 12 hours per weekend

Total hours saved = 32 hours x 52 weeks
= 1,664 hours per year

1,664 hour x $.141 cost per hour
= $234.62 ANNUAL SAVINGS

Payback/ROI

Ultrasonic sensor & power pack = $125.00
Installation = $60.00
Total Cost =$185.00
Payback = 9.5 Months
ROI = 127%

DT-100L & power pack = $160.00
Installation = $60.00
Total Cost =$220.00
Payback = 11.3 Months
ROI = 107%

CI-100 & power pack = $100.00
Installation = $60.00
Total Cost =$160.00
Payback = 8.2 Months
ROI = 147%

039JC.2

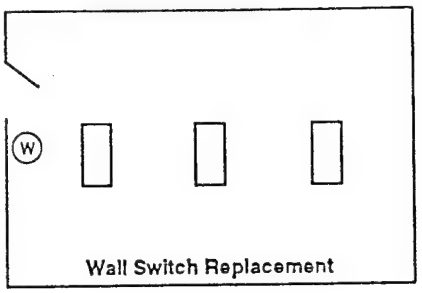
**Sensor, power pack, and installation costs are approximate.

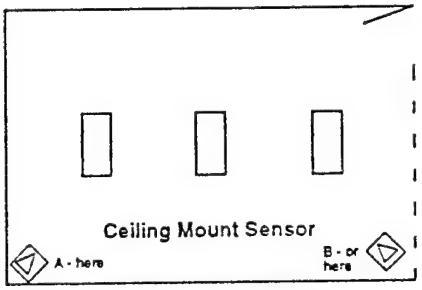
PIR Sensors and PIR Automatic Wall Switches in Building Areas of Under 300 Square Feet

Application

Offices, computer rooms, maintenance areas, vending areas, copy rooms, utility rooms.

1. Check square footage of area.
2. Use coverage templates.
3. Make sure PIR sensors have clear view of the controlled area.
4. Place sensor or "mask" lens so it does not "see" outside the room.
5. Specify time-delay and sensitivity to match activity level of the space.





(W) WI or WS Series Automatic Wall Switch

▷ WPIR Sensor
For enclosed office, use placement A or B. If the wall on the right does not exist, use placement B.

Savings

3 - 176 Watt 2' x 4' Troffers
= .528Kw x $.10 per Kwh
= $.053 cost per hour

Save 4 hours per day Mon-Fri
Save 12 hours per weekend

Total hours saved = 32 hours x 52 weeks
= 1,664 hours per year

1,664 hour x $.053 per hour
= $88.19 ANNUAL SAVINGS

Payback/ROI

WI or WS Wall Switch = $60.00
Installation = $20.00
Total Cost =$80.00
Payback = 10.9 Months
ROI = 110%

WPIR & power pack = $80.00
Installation = $60.00
Total Cost =$140.00
Payback = 19 Months
ROI = 63%

039JC.2

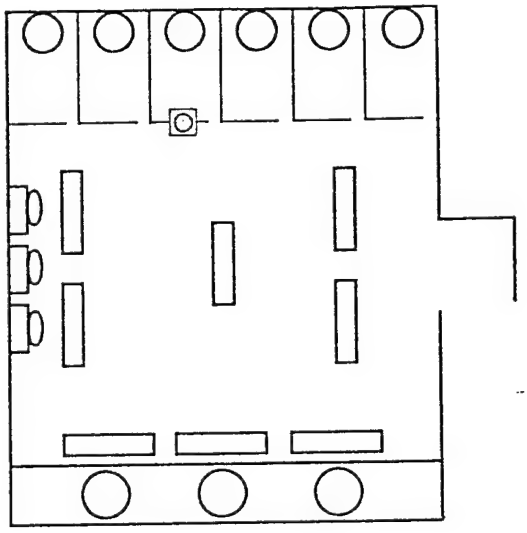
**Sensor, power pack, and installation costs are approximate.

Ultrasonic Sensors in Restrooms

Application

Large restrooms (with or without partitions).

1. Check square footage of area.
2. Use coverage templates.
2. Place sensor as close as possible to stalls. Ideally, over the top of stall entrance.
3. Make sure ultrasonic sensors are installed 6 to 8 feet away from air supply diffusers.
5. Specify time-delay and sensitivity to match activity level of the space.



Ultrasonic Sensor

Savings

(See enclosed "Timer Test Study")
8 - 80 Watt 2' x 4' Fluorescent fixtures
= .64Kw x .10 per Kwh
= $.064 cost per hour
(Consider exhaust fan and ballast load)

Save 8 hours per day Mon-Fri
(Typically lights in bathrooms are on 16 to 24 hours a day.)
Save 27 hours per weekend

Total hours saved = 67 hours x 52 weeks
= 3,484 hours per year

3,484 hour x $.064 per hour
= $222.98 ANNUAL SAVINGS

Payback/ROI

Ultrasonic sensor & power pack = $125.00
Installation = $60.00
Total Cost = $185.00
Payback = 9.9 Months
ROI = 121%

039.JC.2

**Sensor, power pack, and installation costs are approximate.

APPLICATION – HALLWAYS

Ultrasonic and PIR Sensors in Hallways

Application

Hallways, corridors, aisleways.

1. Check square footage and ceiling height of area.
2. Use coverage templates.
3. Do not use ultrasonic sensor if ceiling height exceeds 14 feet.
4. CI-100's are recommended for aisleways – do not use ultrasonics.
5. Make sure ultrasonic sensors are installed 6 to 8 feet away from air supply diffusers.
6. Point ultrasonic receiver openings down the hallway. Mount CI-100 with lens facing down the hallway.
7. Specify time-delay and sensitivity to match activity level of the space.

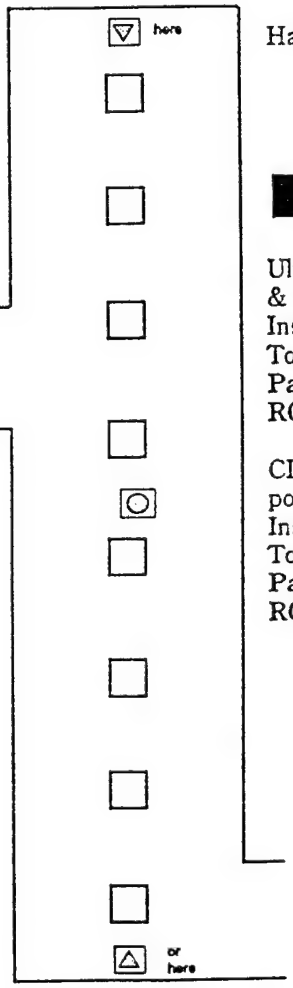
Savings

(See enclosed "Timer Test Study")
8 - 80 Watt 2' x 2' Troffers
= .64Kw x $ .10 per Kwh
= $.064 cost per hour

Save 12 hours per day Mon-Fri
Save 33 hours per weekend

Total hours saved = 93 hours x 52 weeks
= 4836 hours per year

4,836 hour x $.064 per hour
= $309.50 ANNUAL SAVINGS



Hallway length = 80'

Ultrasonic Sensor

CI-100 Passive Infrared Sensor

Payback/ROI

Ultrasonic sensor
& power pack = $125.00
Installation = $60.00
Total Cost = $185.00
Payback = 7.2 Months
ROI = 166%

CI-100 &
power pack = $100.00
Installation = $60.00
Total Cost = $160.00
Payback = 6.2 Months
ROI = 193%

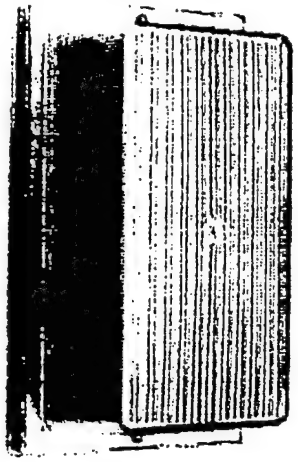
039_JC.2

**Sensor, power pack, and installation costs are approximate.

KENALL®

Herculux™ 4000

High Abuse
18W (2x9W) TT
26W (2x13W) TT
28W Quad Tube
Fluorescent



U.L. Listed for Wet
Damp and Wet Locations

he HERCULUX™ 4000 series is the referred choice for cold weather, high abuse reas that demand a compact size luminaire th an energy efficient fluorescent lamp ource. Typical applications include oorways, stairwells and exterior building cations for schools/universities, park and ecreational facilities and commercial uildings.

EATURES
The new -20°F 28W quad tube fluorescent lamp features approximate lumen output of 100W incandescent and is gasketed for outdoor lighting applications.

Low wattage fluorescent source reduces investment and can be recouped in first lamp replacement cycle.

Low profile and shatterproof design, fully gasketed, corrosion resistant to outside elements enables the fixture to be used in a multitude of applications.

ENERAL SPECIFICATIONS
Refractor—Injection molded polycarbonate lens is clear prismatic and UV stabilized. Nominal thickness .125". Wraparound design encloses and protects all metal parts from the elements.

Finish—All prime cold rolled steel materials are phosphate coated and electrostatically finished after all other operations with a 2.5 mil white urethane powder and baked to form a 92% reflective, smooth, glossy, non-corrosive durable coating.

- **Baseplate**—16 gauge prime cold rolled steel with white urethane finish.
- **Gasket**—Sealight design uses high quality closed cell neoprene rubber to block out moisture, dirt and insects.
- **Ballast**—Uses one or two preheat ballasts; no starter to maintain.
  Model 4018: two 9WTT, 120V, NPF (25°F).
  Model 4026: two 13WTT, 120V, NPF (32°F).
  Model 4028: one 28WQT, 120V, NPF (-20°F).
- **Lamp** (not included)—Uses energy efficient twin tube or quad tube fluorescent lamps.
  Model 4018: two 9W twin tubes.
  Model 4026: two 13W twin tubes.
  Model 4028: one 28W quad tube.
- **Hardware**—Two POSIGRIP tamperproof, stainless steel screws are provided to secure refractor to baseplate.
- **Socket**—Sturdy molded double pin snap-in lampholder.

MOUNTING
UL listed for damp and wet locations, wall installations only—lamp base up.
We recommend using all four KOs provided in the baseplate for mounting with:

- Four ¼-20 machine screws with masonry anchors to mount in brick or concrete.
- Four ¼" lag screws or toggle bolts for mounting in frame construction.

Mounting hardware not included. Please refer to dimensional drawings on page two for exact location of mounting holes. Instruction sheet packaged with each fixture and accessory.

KENALL • 1020 Lakeside Drive • Gurnee, IL 60031 • 708/360-8200 • FAX 708/360-1781

TOTAL P.03

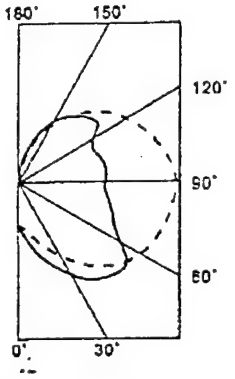
PHOTOMETRIC DATA

MODEL 4028

One 28W OT
Efficiency = 62.6%
Report #ITL41245

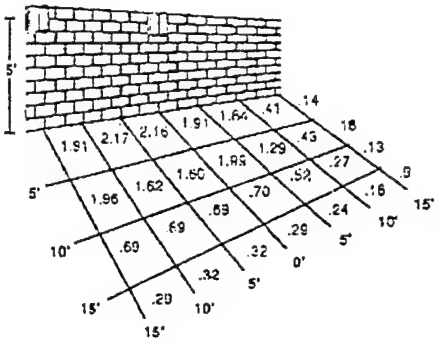
Clear Prismatic Lens
Uplight = 45.1%

Wall Mounted
CIE Type Direct-Indirect



Coefficients of Utilization - Zonal Cavity Method
Effective Floor Cavity Reflectance 0.20

RC	70				50			30			0
RW	70	50	30	10	50	30	10	50	30	10	0
0	63	63	63	63	54	54	54	46	46	46	34
1	54	51	48	45	45	43	38	38	34	32	23
2	46	43	38	34	38	32	29	32	27	25	17
3	40	37	32	27	31	27	23	25	23	19	13
4	35	32	27	22	27	22	19	22	19	16	10
5	30	28	23	19	23	19	16	19	16	13	8
6	26	25	20	16	21	17	13	17	14	11	7
7	23	22	17	13	18	15	11	15	12	9	6
8	20	20	15	12	17	13	10	14	11	8	5
9	18	18	13	10	15	11	8	13	9	7	4
10	24	17	12	9	14	10	8	12	9	6	4



OPERATING SPECIFICATIONS

28WOT

LAMP: 1600 Lumens, 28 Watt, 10,000 Hour Life

BALLAST: One Preheat, -20°F to 90°F Ambient*

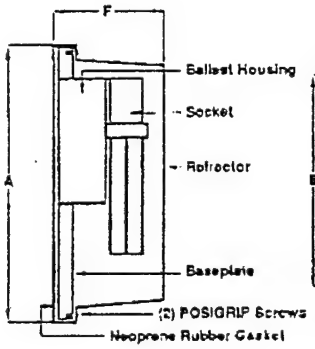
NUMBER OF LAMPS	1
LINE VOLTAGE (V)	120
MAXIMUM CURRENT (A)	.590
OPERATING CURRENT (A)	.475
INPUT POWER (W)	30
POWER FACTOR	NPF

*The 28WOT system is specifically designed for cold environments. General use in warm ambient conditions may result in inefficient operation and therefore is not recommended.

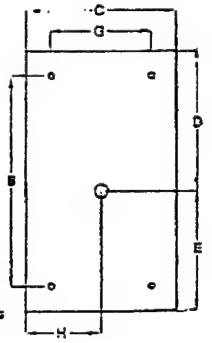
DIMENSIONS

4000 Series
Width: 6" Depth: 4.125" Height: 10.5

Side & Cutaway View



Baseplate Back View



Size	A	B	C	D	E	F	G	H
in.	10.5	8.5	6	5.65	4.65	4.125	4	3
cm.	26.67	21.59	15.24	14.35	11.81	10.48	10.16	7.62

ORDERING INFORMATION

Catalog number	Lens	Wattage (lamp type)	Voltage/ power factor	Starting temp (F)	Posigrip screws
4018	Prismatic	18W (2x9WTT)	120/NPF	25°	Two
4026	Prismatic	26W (2x13WTT)	120/NPF	32°	Two
4028	Prismatic	28W (F28QT)	120/NPF	-20°	Two

ACCESSORY

4000A Seam welded stainless steel surface adapter for wet locations

NOTES:

All Kenall high abuse fixtures are provided with POSIGRIP screws. Be sure to order 9500 screwdrivers with all drop shipments of Kenall high abuse fixtures.
Availability and specifications subject to change without notice.

Call 1-800-4-KENALL (453-6255) for standard product modification, photometric assistance or reports, product sample requests, technical clarification, product literature and the location or phone number of local sales representative.

Peace of Mind Guarantee

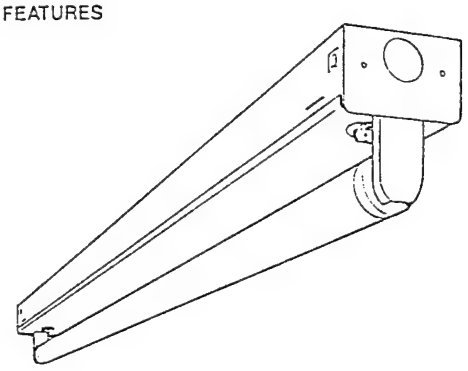
Kenall high abuse luminaires are designed and built to take exceptional physical punishment. When installed according to our instructions, Kenall will repair or replace any fixture using a polycarbonate refractor, diffuser or lens/housing rendered inoperable due to physical abuse within three years of purchase. Thereafter, Kenall will replace any refractor, diffuser or lens/housing broken during the life of the fixture free, subject to a handling charge equal to 25% of the published list price.

KENALL • 1020 Lakeside Drive • Gurnee, IL 60031 • 708/360-8200 • FAX 708/360-1781

STRIP LIGHTS
1 LAMP • 1½', 2', 3' OR 4' LENGTH

S

FEATURES



Also available in tandem-wired (8') lengths

- Heavy-duty channel, die-formed from code-gauge steel
- Sturdy channel cover secured by captive quarter-turn latch for easy access to wireway
- High-gloss, baked white enamel finish
- Combination end plate/channel connector furnished with each fixture
- For unit or row installations, surface or suspended mounting

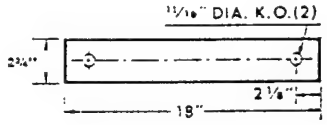
PECIFICATIONS

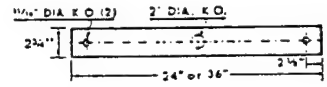
allast
Thermally protected, resetting, Class P ballast standard. Sound rating A, CBM ETL certified, UL listed.

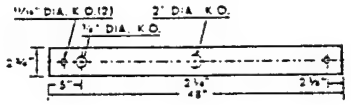
iring & Electrical
AWM, TFN or THHN wire used throughout, rated for required temperatures. Twist-lock lampholders secured by snap-in socket tracks.

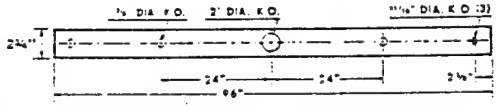
aterials
All metal parts die-formed from code-gauge steel.

inish
Five-stage, iron phosphate pre-treatment ensures superior paint adhesion and rust resistance. All painted parts finished with polyester enamel (85% gloss, 89% reflectance). Salt spray test 500 hours. Hardness minimum 2H.









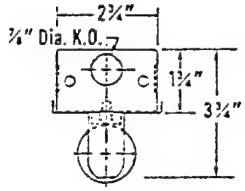
listed and labeled I.B.E.W.—A.F. of L.
ture guaranteed for one year against mechanical defects in manufacture.

MOUNTING DATA For unit or row installation, surface or stem mounting

Unit Installation–Minimum of two hangers required

Row Installation–One hanger per channel plus one per row required.

See ACCESSORIES on reverse side for hanging devices



Dimensions and specifications subject to change without notice.

pproval

Job Information

LITHONIA FLUORESCENT
COMMERCIAL INDUSTRIAL LIGHTING

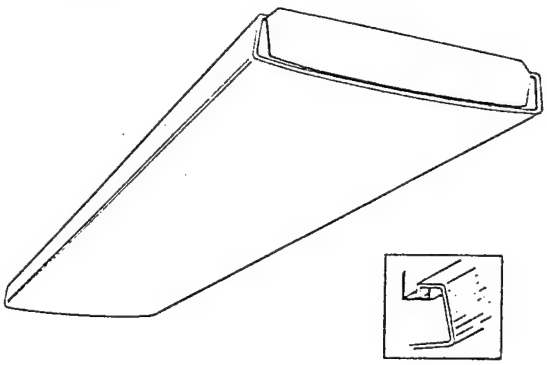
TYPE _____
Specify Voltage 120, 277

SHEET S

LOW-PROFILE WRAPAROUND
WIDE BODY • 2 LAMPS • 4' RAPID START

2LB 240

FEATURES



Also available in tandem-wired (8') length

- Wide-body design (5 3/8") for reduced surface brightness, improved VCP
- Acrylic prismatic diffuser with sonic-welded, injection-molded, luminous ends
- Linear side prisms control brightness, pyramidal bottom prisms minimize lamp image
- Continuous, interlocking support holds diffuser securely, simplifies maintenance
- For surface or stem mounting, unit or row installation. Plug-in couplers permit row mounting without tools
- White enamel end plates–woodgrain appliques optional
- Suitable for mounting on low-density ceilings with SR option

SPECIFICATIONS

Ballast

Thermally-protected, resetting, Class P, HPF ballast standard. Sound rating A, CSM/ETL certified, UL listed. Advance, GE or Universal installed unless otherwise specified.

Wiring & Electrical

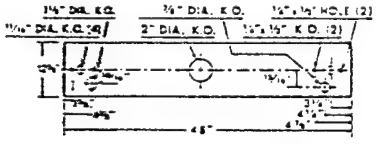
AWM, TFN or THHN wire used throughout, rated for required temperatures. 2" diameter K.O. for easy wiring access. Lampholders snap into channel (individually replaceable without tools).
Input watts: standard 82, energy-saving 66.

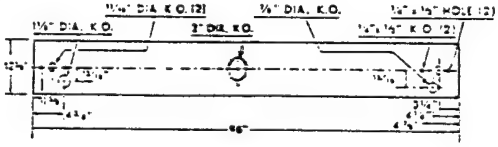
Materials

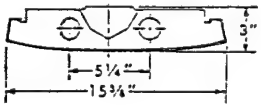
Metal parts die-formed from heavy-gauge steel. Metal gauges: channel and end plates 20-gauge; channel cover 24-gauge. Diffuser is 100% virgin acrylic, .105" thick.

Finish

Five-stage, iron-phosphate pretreatment ensures superior paint adhesion and rust resistance. Channel finished with high-gloss, baked white enamel (85% gloss, 89% reflectance). Salt spray test 500 hours. Hardness minimum 2H.







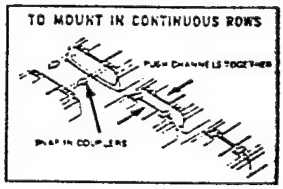
UL listed and labeled I.B.E.W.—A.F. of L.
Fixture guaranteed for one year against mechanical defects in manufacture.

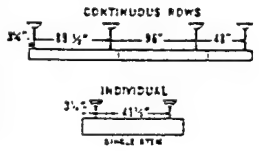
Dimensions and specifications subject to change without notice.

MOUNTING DATA For unit or row installation, surface or stem mounting

Unit Installation–One double-stem (4' only) or two single-stem hangers required

Row Installation–One hanger per fixture plus one per row required





See ACCESSORIES on reverse for hanging devices

Approval

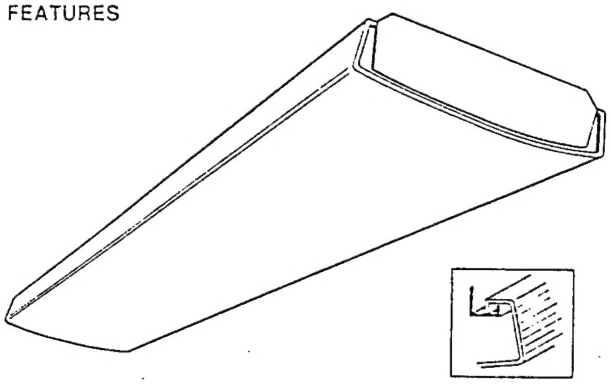
Job Information

LITHONIA®

SHEET 2LB 240

LOW-PROFILE WRAPAROUND
WIDE BODY • 3 LAMPS • 4' RAPID START | **LB 340**

FEATURES



Also available in tandem-wired (8') lengths with (2) 4' lenses

- Acrylic prismatic diffuser with sonic-welded, injection-molded, luminous ends.
- Linear side prisms control brightness, pyramidal bottom prisms minimize lamp image.
- Continuous, interlocking support holds diffuser securely, simplifies maintenance.
- For surface or stem mounting, unit or row installation. Snap-in couplers permit row mounting without tools.
- White enamel end plates — woodgrain appliques available.

SPECIFICATIONS

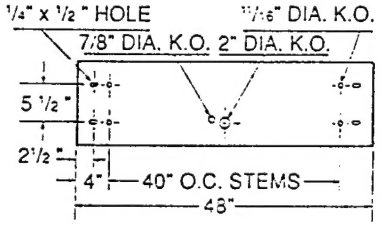
Ballast Data
Thermally-protected, resetting, Class P HPF non-PCB, UL listed. CSA certified ballast is standard. Sound rating A. Standard combinations are CBM approved.

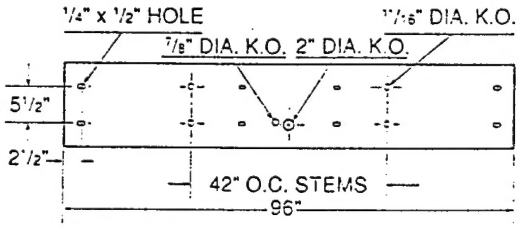
Wiring & Electrical
Fixture bears UL label and is suitable for damp locations. AWM, TFN or THHN wire used throughout, rated for required temperatures. In and out wiring and circuit identification are standard.

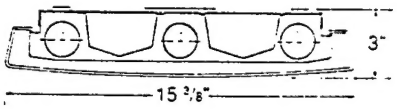
Materials
Metal parts die-formed from code-gauge steel. Diffuser is acrylic. No asbestos is used in this product.

Finish
Five-stage iron-phosphate, pre-treatment ensures superior paint adhesion with rust resistance. Painted parts finished with high-gloss, baked white enamel.

Input Wattage
LB 340 with ES ballasts, std. lamps - 126W
LB 340 with ES ballasts, ES lamps - 110W





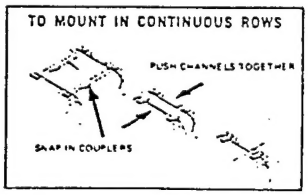


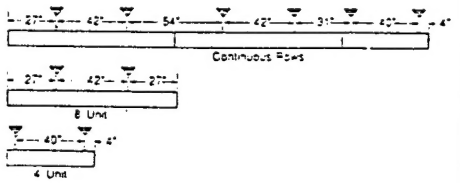
UL listed, CSA certified. Labeled I.B.E.W. • A.F. of L. Guaranteed for 1 year against mechanical defects in manufacture. Dimensions & specifications subject to change without notice.

MOUNTING DATA For unit or row installation, surface or stem mounting

Unit Installation - Four single-stem hangers required.

Row Installation - Four single-stem hangers per fixture required.





See ACCESSORIES on reverse for hanging devices

Approval

Job Information

Type_____
(Specify 120V, 277V or 347V)

LITHONIA FLUORESCENT
COMMERCIAL & INDUSTRIAL LIGHTING

Sheet LB 340

Low-Bay Industrial Lighting

ORDERING SEQUENCE

CATALOG NUMBER | VOLTAGE | OPTIONS (Factory Installed)

- ☐ TXL 50S A20*
- ☐ TXL 70S A20*
- ☐ TXL 100S A20*
- ☐ TXL 150S A20*

- ☐ 120[1]
- ☐ 208
- ☐ 240
- ☐ 277[1]
- ☐ 480
- ☐ TS[2]

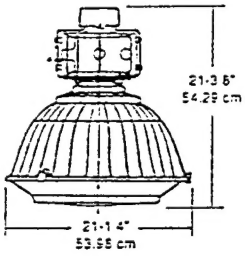
Shipped Installed In Fixture

- ☐ SF Single Fuse (120,277V) n/a TB
- ☐ DF Double Fuse (208,240,480V) n/a TB
- ☐ EC Emergency Circuit (lamp not included)
- ☐ QRS[3] Quartz Restrike System (lamp not included)
- ☐ QRSTD[3] QRS Time Delay (lamp not included)
- ☐ HA 55°C Ambient Operation
- ☐ CR Corrosion Resistant Finish (polyester)
- ☐ CRT Corrosion Resistant Finish (teflon)
- ☐ TEF Teflon Finished Reflector
- ☐ TOB[5] Thru-Wire Outlet Box
- ☐ TOBP[5] Thru-Wire Outlet Box Plug-In
- ☐ PBP[5] Pendant Box Plug-In
- ☐ LCPP[5] Loop, Cord & Plug for TPH & PPH
- ☐ LC3P[5,6,7] Loop, 3' Cord & 15A NEMA Twist Lock Plug
- ☐ HC3P[5,6,7] Hook, 3' Cord & 15A NEMA Twist Lock Plug
- ☐ LRCA[5,8] Loop, 3' Cord & Reloc RCA Connector
- ☐ HRCA[5,8] Hook, 3' Cord & Reloc RCA Connector
- ☐ LUCP[5] Loop Cord and Plug For UPM1
- ☐ LUCPSF[5] LUCP w/Single Fuse (dead front) n/a TB
- ☐ LUCPDF[5] LUCP w/Double Fuse (dead front) n/a TB
- ☐ UCP[5] Universal Cable & Plug
- ☐ UCPSF[5] UCP w/SingleFuse (dead front) n/a TB
- ☐ UCPDF[5] UCP w/DoubleFuse (dead front) n/aTB
- ☐ TR Remote Ballast
- ☐ TRCP3[5,6,9] TR w/Pre-Wired Cable
- ☐ MRB Magnetic Regulator Ballast (150W only)
- ☐ CWA Constant Wattage Autotransformer (150W only)
- ☐ WL Wet location UL Label
- ☐ SSS Stainless Steel Screws
- ☐ SLR Stainless Steel Lens Rings
- ☐ CF Charcoal Filter

Shipped Separately [4]

- ☐ HKM[5] Fixture Hook - Male
- ☐ HKMG[5] Grommetted Fixture Hook - Male
- ☐ LPM[5] Fixture Loop - Male
- ☐ LPMG[5] Grommetted Fixture Loop - Male
- ☐ TPH[5] Thru-Wire Power Hook
- ☐ PPH[5] Pendant Power Hook
- ☐ UPM[5] Universal Power Module
- ☐ UPM1[5] UPM w/Hook Adapter Plate
- ☐ UPM2[5] UPM w/Wiring Block
- ☐ UPM3[5] UPM w/Hook Adapter Plate & Wiring Block

* Optional polycarbonate refractor available. Substitute P20 for A20.



WATTS	S/MH	WEIGHT lbs.	WEIGHT kg.
50	1 9	11	5
70	1.8	12	5
100	1.9	14	6
150	1 9	15	7

NOTES:
1. May also be ordered with 5', 10', 15' cord lengths.
2. Multi-Tap Ballast (120,208,240,277V).
3. Quartz lamp wattage not to exceed ballast wattage rating. For 50, 70W, use 100W quartz lamp.
4. May be ordered as accessory. MUST see Industrial Accessories Sheet for ordering information.
5. 36" cable to connect optical to remote ballast.
6. Not available with WL option.
7. 20 amps standard 480V.
8. Provided with dual tap (120/277V) ballast when ordered as 120V or 277V, except w/MRB option.
9. For Complete Description & Application Information, See Options & Accessories Sheet I-O/A.

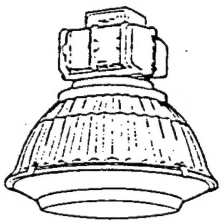
ACCESSORIES (Field Installed)
(order as separate line item)

Cat. No.	Description
HKF[5]	Fixture Hook - Female
LPF[5]	Fixture Loop - Female
SCK	Safety Chain Kit
TMB[5]	Twin Mounting Bar (consult factory)

Fixture Type:

TXL

HIGH PRESSURE SODIUM
50/70/100/150W
10' to 18' Mounting



SPECIFICATIONS

HOUSING - Rugged, lightweight, die-cast aluminum with dark bronze polyester powder finish. Electrical components are opposed horizontally and heat-sinked to ballast housing for cooler operation.

BALLAST - High reactance high power factor. 180°C class H insulation system.

OPTICS - Injection molded virgin acrylic lens, fully-fluted anodized aluminum reflector. Positive latch refractor clips facilitate removal for maintenance and cleaning, gasketed refractor and reflector inhibits the entrance of ambient contaminants. All distribution patterns are widespread.

INSTALLATION - Pendant splice box threaded for ¾" conduit (standard). Complete line of mounting options and accessories available.

LISTING - UL 1572 listed for -30°C to 40°C ambient operation.& damp locations. 55°C operation available.

SOCKET - Porcelain, vertically oriented mogul base socket with copper alloy nickel plated screw shell and center contact. UL listed 1500W - 600V, 4KV pulse rated.

LITHONIA HI-TEK
INDUSTRIAL/OUTDOOR LIGHTING
A DIVISION OF LITHONIA LIGHTING

2/89
TXL S1

Low-Bay Industrial Lighting

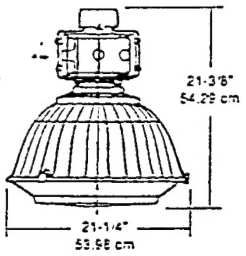
ORDERING SEQUENCE

CATALOG NUMBER	VOLTAGE	OPTIONS (Factory Installed)
✓	✓	✓

- ☐ TXL 200S A20*
- ☐ TXL 250S A20*
- ☐ TXL 400S A20*

- ☐ 120
- ☐ 208
- ☐ 240
- ☐ 277
- ☐ 480
- ☐ TB[2]

* Optional polycarbonate refractor available. Substitute P20 for A20.



WATTS	S MH	WEIGHT lbs.	kg.
200	1.9	17	8
250	1.8	21	9
400	1.5	27	13

Shipped Installed In Fixture

- ☐ SF Single Fuse (120,277V) n/a TB
- ☐ DF Double Fuse (208,240,480V) n/a TB
- ☐ EC Emergency Circuit (lamp not included)
- ☐ ORS[3] Quartz Restrike System (lamp not included)
- ☐ ORSTD[3] ORS Time Delay (lamp not included)
- ☐ HA 55°C Ambient Operation
- ☐ CR Corrosion Resistant Finish (polyester)
- ☐ CRT Corrosion Resistant Finish (teflon)
- ☐ TEF Teflon Finished Reflector
- ☐ TOS[4] Thru-Wire Outlet Box
- ☐ TOBP[4] Thru-Wire Outlet Box Plug-In
- ☐ PBP[4] Pendant Box Plug-In
- ☐ LCPP[4] Loop, Cord & Plug for TPH & PPH
- ☐ LC3P[1,4,7] Loop, 3' Cord & 15A NEMA Twist Lock Plug
- ☐ HC3P[1,4,7] Hook, 3' Cord & 15A NEMA Twist Lock Plug
- ☐ LRCA[1,4] Loop, 3' Cord & Reloc RCA Connector
- ☐ HRCA[1,4] Hook, 3' Cord & Reloc RCA Connector
- ☐ LUCP[4] Loop Cord and Plug For UPM1
- ☐ LUCPSF[4] LUCP w/Single Fuse (dead front) n/a TB
- ☐ LUCPDF[4] LUCP w/Double Fuse (dead front) n/a TB
- ☐ UCP[4] Universal Cable & Plug
- ☐ UCPSF[4] UCP w/SingleFuse (dead front) n/a TB
- ☐ UCPDF[4] UCP w/DoubleFuse (dead front) n/aTB
- ☐ TR Remote Ballast
- ☐ TRCP3[1,4,5,7] TR w/Pre-Wired Cable
- ☐ MRB Magnetic Regulator Ballast (250,400W only)
- ☐ WL Wet Location UL Label
- ☐ SSS Stainless Steel Screws
- ☐ SLR Stainless Steel Lens Rings
- ☐ CF Charcoal Filter

Shipped Separately [4]

- ☐ HKM[4] Fixture Hook - Male
- ☐ HKMG[4] Grommetted Fixture Hook - Male
- ☐ LPM[4] Fixture Loop - Male
- ☐ LPMG[4] Grommetted Fixture Loop - Male
- ☐ TPH[4] Thru-Wire Power Hook
- ☐ PPH[4] Pendant Power Hook
- ☐ UPM[4] Universal Power Module
- ☐ UPM1[4] UPM w/Hook Adapter Plate
- ☐ UPM2[4] UPM w/Wiring Block
- ☐ UPM3[4] UPM w/Hook Adapter Plate & Wiring Block

NOTES:

1. May also be ordered with 5', 10', 15' cord lengths.
2. Multi-Tap Ballast (120,208,240,277V).
3. Quartz lamp wattage not to exceed ballast wattage rating.
4. May be ordered as accessory. MUST see Industrial Accessories Sheet for ordering information.
5. 35" cable to connect optical to remote ballast.
6. Not available with WL option.
7. 20 amps standard 480V.

ACCESSORIES (Field Installed)
(order as separate line item)

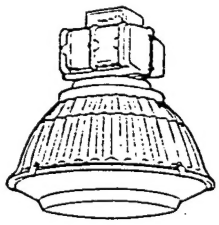
Cat. No.	Description
HKF[4]	Fixture Hook - Female
LPF[4]	Fixture Loop - Female
SCK	Safety Chain Kit
TMB[4]	Twin Mounting Bar (consult factory)

For Complete Description & Application Information, See Options & Accessories Sheet I-D/A.

Fixture Type:

TXL

HIGH PRESSURE SODIUM
200/250/400W
14' to 20' Mounting



SPECIFICATIONS

HOUSING - Rugged, lightweight, die-cast aluminum with dark bronze polyester powder finish. Electrical components are opposed horizontally and heat-sinked to ballast housing for cooler operation.

BALLAST - High power factor. Constant wattage autotransformer. 180° class H insulation system.

OPTICS - Injection molded virgin acrylic lens, fully-fluted anodized aluminum reflector. Positive latch refractor clips facilitate removal for maintenance and cleaning, gasketed refractor and reflector inhibits the entrance of ambient contaminants. All distribution patterns are widespread.

INSTALLATION - Pendant splice box threaded for ¾" conduit (standard). Complete line of mounting options and accessories available.

LISTING - UL 1572 listed for -30°C to 40°C ambient operation & damp locations. 55°C operation available.

SOCKET - Porcelain, vertically oriented mogul base socket with copper alloy nickel plated screw shell and center contact. UL listed 1500W - 600V, 4KV pulse rated.

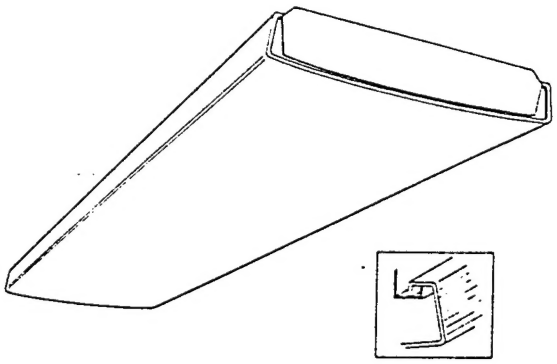
LITHONIA HI-TEK
INDUSTRIAL/OUTDOOR LIGHTING
A DIVISION OF LITHONIA LIGHTING

2/89
TXL S2

LOW-PROFILE WRAPAROUND
WIDE BODY • 4 LAMPS • 4' RAPID START

LB 440

FEATURES



Also available in tandem-wired (8') length

- Wide-body design (15 ⅜") for reduced surface brightness, improved VCP
- Acrylic prismatic diffuser with sonic-welded, injection-molded, luminous ends
- Linear side prisms control brightness, pyramidal bottom prisms minimize lamp image
- Continuous, interlocking diffuser support prevents accidental opening, simplifies maintenance
- For surface or stem mounting, unit or row installation. Plug-in couplers permit row mounting without tools
- White enamel end plates–woodgrain appliques optional
- Suitable for mounting on low-density ceilings with SR option

SPECIFICATIONS

Ballasts

Thermally-protected, resetting, Class P, HPF premium ballasts standard (12°C cooler operation). Sound rating A, CBM/ETL certified, UL listed. Advance, GE or Universal installed unless otherwise specified.

Wiring & Electrical

AWM, TFN or THHN wire used throughout, rated for required temperatures. 2" diameter K.O. for easy wiring access. Lampholders snap into channel (individually replaceable without tools).

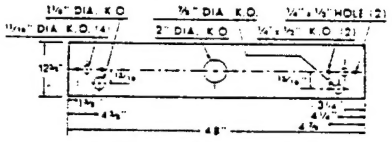
Input watts: standard 165, energy-saving 133.

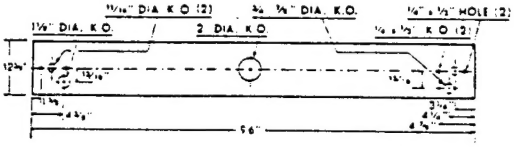
Materials

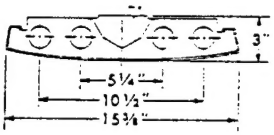
Metal parts die-formed from heavy-gauge steel. Metal gauges: channel and end plates 20-gauge; channel cover 24-gauge. Diffuser is 100% virgin acrylic, .105" thick.

Finish

Five-stage, iron-phosphate pretreatment ensures superior paint adhesion and rust resistance. Channel finished after fabrication with high-gloss, baked white enamel (85% gloss, 89% reflectance). Salt spray test 500 hours. Hardness minimum 2H.







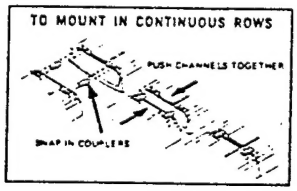
UL listed and labeled I.B.E.W.—A.F. of L.
Fixture guaranteed for one year against mechanical defects in manufacture.

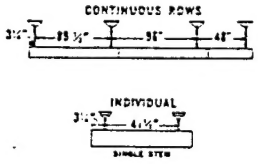
Dimensions and specifications subject to change without notice

MOUNTING DATA For unit or row installation, surface or stem mounting

Unit Installation–One double-stem (4' only) or two single-stem hangers required

Row Installation–One hanger per fixture plus one per row required





See ACCESSORIES on reverse for hanging devices

Approval

Job Information

LITHONIA

SHEET LB 440